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1923, pp. 483–1097,

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PROCEEDINGS

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PAPERS.

26. On Mammals collected by Captain Shortridge during the Percy Sladen and Kaffrarian Museum Expedition to the Orange River. By Oldfield Thomas, F.R.S., F.Z.S., and Martin A. C. Hinton, F.Z.S.

[Received May 15, 1923: Read June 12, 1923.]

(Published by permission of the Trustees of the British Museum.)

Thanks to the generosity of the Percy Sladen Trustees, and the kind co-operation of the authorities of the King William's Town Museum, Capt. Guy Shortridge, already so well known as a collector in Burma and elsewhere, has been enabled to make a collecting expedition to the Middle Orange River, a region whence the British Museum has received but very few mammals, and one whose faunal characteristics much needed investigation.

The only considerable collections that have been received from this direction were one made in Little Namaqualand by Mr. C. H. B. Grant for the Rudd Exploration *, a later one formed by Messrs. Woosnam & Dent in Bechuanaland †, and finally that obtained on Mr. Woosnam's expedition to Lake Ngami and described by Capt. Dollman ‡.

The present collection was obtained in the neighbourhood of Upington, on the Middle Orange River, and forms a very important addition to our materials for the study of the mammal fauna of South-West Africa. It consists of 378 specimens

* See Thomas & Schwann, P. Z. S. 1904, vol. i. p. 171.
† Schwann, P. Z. S. 1906, vol. i. p. 101.
‡ Ann. & Mag. N. H. (8) vol. vi. p. 388, 1910.

representing 34 species, and as these were all obtained in the course of two months, it forms a striking tribute to Capt. Shortridge's energy and collecting ability.

We have had occasion to describe five species and sub-species as new, partly from the collection itself, and partly from other collections which the study of the fresh material has enabled us more fully to understand. Such more accurate discrimination of earlier material is by no means the least of the benefits to science rendered by the collection of such series as the present.

Half of the collection, including all the types, is presented to the National Museum by the Percy Sladen Trustees, and half is returned to the Kaffrarian Museum, King William's Town, of which Capt. Shortridge is Curator. He has sent us the following report on this expedition, and as it gives a good account of the natural characteristics of the region, we have thought it well to publish it nearly *in extenso* :—

"Through the kindness of the Administrator, Sir Frederick de Waal, special shooting facilities were obtained; while by arrangement with Dr. L. Péringuey, Director of the South African Museum, considerable rail fare reductions were secured.

"During the first six weeks I was joined by Mr. A. White, who was sent by Dr. Péringuey to gain experience in trapping and other field work, in which he proved himself a keen and useful assistant.

"Later, during my visit to and below the Augrabies Falls (which by crossing a number of side streams were seen while in flood) I was accompanied by Mr. W. Louw, who acted as assistant, and Dutch interpreter.

"The country generally, with its sparse rainfall, but remarkable strip of rich irrigable soil that varies from a width of under a hundred yards to over two miles on either side of the river, is in some ways quite like Egypt on a small scale, and should be capable of great development, although the river itself, with its dense belt of low trees, and muddy water, is more reminiscent of the Jordan.

"This belt is by far the most striking feature in the district. The trees grow only on the low ground that is periodically flooded, and consist largely of Willows, Mimosa and other shade trees. There is little or no real undergrowth, and prior to cultivation the soil between the trees is bare and loose. An extraordinary variety of birds collect and breed here.

"On either side of this alluvial belt the country is bare and arid, sparsely covered with very low scrub with here and there a few isolated kopjes, which are supplemented to the westward by considerable ranges of rocky hills that commence about halfway between Upington and Kakamas.

"In several places on the north bank strips of typical red Kalahari sand extend to the river, which roughly forms the southern boundary of the Kalahari. The river itself should not otherwise prove an important barrier between any two faunistic regions, as it is intersected for nearly its whole length between Upington and the Falls by innumerable islands which are often only divided by narrow channels, most of which cease running or become entirely dry when the river is low; while again the tree belt is broken in several places for short distances by rocky hill ranges that run astride of the river.

"The first three camps (altitude 2,600 ft. approximately) were made at Louisvale, a new but very progressive irrigation settlement on the south bank of the river, at points between ten and fifteen miles west from Upington; but as Louisvale is not marked on small-scale maps, all specimens obtained in that district were labelled: 'Near Upington—south bank of Orange River.'

"These camps, although within a few miles of each other, enabled me to make collections among kopjes and rocky areas; salt-bush and typical open country; the river tree belt; and near cultivation.

"The fourth camp (altitude 2,000 ft. approximately) was made on the north bank of the river, close to the little known Orange River (Augrabies) Falls, about ninety miles west of Upington.

"The river here splits up into several streams, the main and two subsidiary Falls descending into a narrow gorge, said to be about 500 feet in depth. Two others—one almost equal in volume to the main fall—enter several miles lower down.

"Except for a few squatters, who are chiefly engaged in looking after herds of donkeys and goats, there is no population in the neighbourhood.

"A fifth camp (altitude 1,500 ft. approximately) was made also on the north bank, about twelve miles below the Falls, a few miles above where the dry Molopo joins the Orange River, which has widened out again into large pools that resemble a string of lakes, shut in by high rocky hills and thinly fringed with trees.

"Except for a few wandering Hottentots the country here is entirely uninhabited.

"It may be noted that neither *Chrysochloris* nor *Cryptomys* were met with. I found no signs of molehills and was assured by residents that they did not exist in the region.

"Hedgehogs, if not absent, must be extremely rare, as they appear to be practically unknown along this section of the river. Shrews may occur, but there is little doubt that they are generally scarce throughout the dry South-Western area.

"Antbears, judging by the comparative scarcity of their burrows, are not plentiful.

"At Upington I saw part of an old dry skin of a Pangolin that had been obtained in that district.

"A few residents spoke vaguely of Wild Pig from some of the islands, but their present occurrence is exceedingly doubtful.

"Among the larger game reported to occur within from 50–100 miles of Upington in the direction of the Kalahari Desert may be included:—Red Hartebeest, Blue Wildebeest, Black Wildebeest (said to exist in a wild state), Gemsbuck, Kudu (a single straggler was recently reported from near the Falls), Springbuck, Duiker, Zebra, Lion, Leopard, Wild Dog, Spotted and Brown Hyæna, *Proteles*, and *Cynælurus*."

1. CERCOPITHECUS PYGERYTHRUS Cuv.

♂. 228. ♀. 7, 195. Louisvale, near Upington. 2600′.
♂. 343. Augrabies Falls, 90 miles W. of Upington. 2000′.

"Plentiful among the trees that fringe the banks of the Orange River, probably rarely if ever leaving the wooded course of the river, along which it is said to extend as far as its mouth, although, as there is an extensive break in the wooded area below the Falls, this remains to be confirmed.

Like the Burmese and Malay Crab-eating Monkeys they take readily to water when hunted. Often doing a considerable amount of damage among crops and fruit; their consequent persecution has rendered them rather shy.

Baboons were observed among the rocky hills at and below the Falls; but nowhere further east."

2. NYCTERIS DAMARENSIS Pet.

377, 378. Louisvale.

The specific distinction of *damarensis* from *capensis* depends mainly on the greater size of the ears, but there is some variation in the size of these organs, and every probability that the two forms will be found to intergrade. Dr. Andersen, however, has recognised *damarensis* as a species, and we therefore provisionally follow his example.

3. EPTESICUS CAPENSIS A. Sm.

Six males, thirty-one females, in skin, and seven in spirit. Louisvale.

"By far the most plentiful bat in the district. Appearing well before dusk, frequently collecting in large numbers over water.

Most of the specimens obtained were found roosting in hollow trees along the banks of the Orange River; but also hiding by day under the roofs of houses."

4. NYCTINOMUS BOCAGEI Seabra.

♂. 245, 250, 251, 314, 379. ♀. 267, 315.

"Obtained in hollow trees; singly or in pairs; often in company with *Eptesicus*. Seldom observed in flight, but possibly a late flyer.

A Fruit-bat, considered to be somewhat rare, occurs around Upington, having possibly found its way there since the cultivation of fruit was started."

5. ELEPHANTULUS RUPESTRIS A. Sm.

♂. 24, 60, 86, 89, 126, 133, 146, 153, 226. ♀. 52, 69, 114, 123, 124, 132, 145. Louisvale.

"A rock Elephant-shrew, the only species observed, although an individual described from open country near Upington on the north bank of the river may prove to be a species of *Macroscelides*.

There is a narrow naked gland, most conspicuous in adult males, and exuding moisture when fresh, on the underside of the tail, about half an inch from its base, which is easily noticeable during life owing to the slight swelling of that portion, and has a distinct although inoffensive smell of musk.

Elephant-shrews are amongst the most attractive of all small mammals. When caught alive they are quiet and seemingly not very timid; never attempting to bite even if a finger is placed inside their mouths. When handled, the snout—which is very sensitive—is moved about in a circular manner to avoid any contact. Extremely active; their movements are Jerboa-like, and when hopping among rocks curiously resemble a small ball bouncing about. Although normally diurnal, during the hot season they are more frequently to be seen at dusk, and even on moonlight nights. This appears to be the case with a large number of small desert mammals, many of which may become diurnal during the cold weather. Although without doubt chiefly insectivorous, they may occasionally be taken in traps baited with mealies. No Elephant-shrews were observed in the rocky country around the Augrabies Falls."

6. FELIS PARDUS L.

♂. 374. Kakamas, 60 miles W. of Upington. 2300′.

"Rare along the Orange River between Kakamas and Upington, although apparently becoming rather more numerous in the rocky hill country in the neighbourhood of the Augrabies Falls.

Said also, together with *Cynælurus*, to become more plentiful northwards in the Kalahari area."

7. FELIS OCREATA CAFRA Desm.

♀. 206. Louisvale. 2600′.
354. Skull only. Upington district.

"Fairly plentiful, and, as usual, very destructive to poultry and small game. Very numerous further north, judging by the number of Karosses sent down.

A cat that is undoubtedly *F. nigripes* has been described to me from the Zwart Modder district, some 100 miles north of this river.

Karosses made from the skins of *F. serval* and *F. caracal* are frequently obtained from Reitfontein and elsewhere in the neighbourhood of the Kalahari."

8. Genetta felina Thunb.

♂. 350. Louisvale. 2600′.
364. Skull only. Upington district.
363. Skull only. Augrabies Falls.

"Said to be fairly plentiful, and evidently becoming decidedly more numerous further north, judging from the number of Karosses sent down from Reitfontein and elsewhere."

9. Herpestes ratlamuchi A. Smith.

♂. 19. ♀. 8, 26. Louisvale. 2600′.
365, 366, 367. Skulls only. Upington district.

Hitherto the type of this species—B.M. No. 46. 6. 1. 14—has been the only example of it in the British Museum, so that these specimens form a valuable accession. That type, which is also the type of Smith's *badius*, was obtained "between Latakoo and the tropic"—probably therefore on the Molopo River.

"Not plentiful. In this district at any rate, like the Vervet and local tree-rat, they seem to be strictly confined to the belt of trees on either side of the Orange River.

Said never to occur among kopjes or in open country. Although occasionally living in burrows excavated either by themselves or Zorillas they are very largely arboreal, and are active tree-climbers, which would be necessary in an area so frequently inundated.

To a certain extent diurnal.

They are said occasionally to take to a vegetarian diet, and to be fond of digging up and eating ground-nuts. One specimen was caught in a trap baited with mealies.

A grey mongoose—probably *H. pulverulentus*—was twice observed in rocky country away from the river."

10. Cynictis penicillata G. Cuv.

♂. 14, 22, 213, 244. ♀. 20, 189.

Probably referable to *C. p. pallidior* Thos. and Schw., of which they would appear to be bleached summer examples.

"Plentiful, diurnal, gregarious.

These meerkats were nearly always found living with or close to colonies of *Xerus capensis*, and they do not appear to interfere with each other. In any case, it is impossible to distinguish their warrens.

I never observed *Suricata* in this district. Wherever it is plentiful it is very conspicuous and easily obtained, frequenting the same localities as *Cynictis* and *Geosciurus*; so that, even if according to a few residents it actually does occur locally, it can be by no means numerous. It is reported from the country round Kenhart."

11. Canis mesomelas Schr.

♀. 344. Augrabies Falls. 2000′.
353. Skull only.

"Fairly numerous, especially in the neighbourhood of hills or rocky country. As with other small carnivora, judging from local Karosses, becoming considerably more abundant further north.

African jackals are far less noisy than the Indian species, which may be heard during the night at all times."

12. Vulpes chama A. Sm.

356–8. Skulls only. Upington district.

These skulls were purchased. The exact locality where they were obtained is unknown, except that it was in the vicinity of the Orange River.

"As Karosses made from fox skins from Reitfontein are scarce and rather expensive, it appears that they are either comparatively rare or difficult to procure. Said to exist close to the Augrabies Falls, but I could obtain no other information regarding their occurrence near the river."

13. Mellivora ratel Sparrm.

352. Skull only. Upington district.

"Widely distributed, but not plentiful. Entirely nocturnal and seldom seen. Tracks were observed near the Augrabies Falls, while among rocks a deserted bees'-nest was found that had evidently been disturbed by one of these animals."

14. Ictonyx striatus Perry.

♂. 72, 121, 159, 202, 248. ♀. 18, 119, 120, 188, 249. Louisvale.
368. Skull only. Upington district.

"Plentiful, nocturnal. Very easy to trap. It is easily tamed, even if caught when nearly or entirely full-grown, when it will seldom, if ever, make use of its offensive scent."

15. Lutra maculicollis Licht.

♀. 322. Young, sex unknown, 321. Louisvale. 2600′.

"Not plentiful. If, as is reported, *Aonyx capensis* also occurs in this district, this species is probably the more numerous. Very few otter tracks were observed anywhere along the river."

16. Geosciurus capensis namaquensis Licht.

♂. 13, 21, 201, 311. ♀. 12, 190. Louisvale, near Upington, S. bank of river. 2600′.

These specimens are quite unlike those of *G. capensis* previously in the Museum, and show, by their pale cinnamon-buffy colour, that the Ground Squirrel of the Kalahari and Namaqualand should be subspecifically distinguished from the ordinary more brownish form of the rest of the colony.

Although Lichtenstein's description of his *Sciurus namaquensis** is curiously inapplicable to *Geosciurus*—"corpore supra nigro; subtus brunneo," yet the locality, the presence of white lateral lines, and the universal assignation of his name to the Cape Ground Squirrel, seem to render it certain that it really was referable to this animal, and we can only suppose that he had a very dirty specimen in the old Holthuisen collection. This squirrel is also the *Sciurus levaillantii* of Kuhl.

"Plentiful, diurnal, gregarious.

During the hot weather their coats become particularly short and ragged.

There is no doubt that *Geosciurus*, *Cynictis*, and also *Suricata* where it occurs, frequently inhabit the same warrens, as traps often catch them alternately.

Probably the thickness of their skins, in addition to their unusually great muscular strength, protect them to a great extent from the smaller carnivores. These squirrels are savage, and in captivity do not make good pets, as they are uncertain in temper."

17. TATERONA MILIARIA STELLÆ Wr.

♂. 49, 69, 200, 240, 243, 246, 247, 263. ♀. 50, 51, 158, 212, 215, 286, 312.

These specimens average paler than the original series from Kuruman, but this would seem to be due to seasonal bleaching, as Mr. Woosnam's skins were collected in April and May, and the present set in full summer—November to January.

"Plentiful. Social, rather than gregarious. Attracted by cultivation. Nocturnal. Away from settlements chiefly occurring along the beds of dry water-courses.

Their burrows, which are easy to find, are excavated among the thick scrubby bushes that grow in such localities."

18. DESMODILLUS AURICULARIS A. Sm.

♂. 171, 175, 210, 225, 234, 238, 239, 300, 302, 317. ♀. 176, 178, 179, 205, 209, 216, 217, 232, 233, 237, 298, 299, 301, 319. Louisvale. 2600′.

♂. 349. ♀. 338. Augrabies Falls.

These specimens vary very considerably in colour, many being as pale as the Kalahari *D. a. pudicus* Dollm., while others closely match the true *D. auricularis*. It would seem therefore that we are here on the meeting ground of the two forms.

There seems a tendency for the darker coloured animals to have

* Cat. Rer. Nat. p. 2, 1793.

larger bullæ; but many more specimens are needed before this can be definitely asserted.

"Plentiful; occurring in flat open country.

Their burrows, which are excavated in open sandy patches, are circular, small for the size of the animal, and generally more or less perpendicular, resembling those of an open country elephant-shrew (*Macroscelides*). Nocturnal. Attracted by cultivation, and said occasionally to appear in large numbers.

Individuals from the same locality varied considerably in colour."

19. Parotomys (Liotomys) littledalei Thos.

40 specimens. Louisvale.

Quite agree with the specimens from Bushman Land (Kenhart) obtained and presented by Maj. Littledale. This striking animal must be very restricted in range as it was only described in 1918 in spite of its evident local abundance.

There is a good deal of variation in the general colour, but the more brightly toned specimens just match the type from Tuin, Kenhart.

"Local, but extremely plentiful where they occur; their presence coinciding with the large but rather infrequent patches of a succulent species of salt-bush, which they appear almost exclusively to feed on.

Diurnal, not attracted by cultivation. Their burrows, which are excavated among the roots of thick masses of salt-bush, are very conspicuous, being interpolated above ground with thick networks of sticks, and the amount of this work possibly makes them appear to be even more numerous and more gregarious than they really are.

Not readily trapped, this genus being probably less omnivorous than most other small rodents."

20. Rattus (Praomys) namaquensis A. Sm.

36 specimens. Louisvale.

♂. 325, 326, 333, 329. ♀. 327, 331, 334, 336. Augrabies Falls, 90 miles W. of Upington. Mammæ 1–2=6.

"A rock rat. Plentiful on either side of the Orange River between Upington and the Augrabies Falls; but strictly confined to kopjes and rocky country. Appearing to become rather less plentiful among the hill ranges below the Falls. This may, however, be only a local scarcity owing to a shortage of their favourite food, or on account of frequenting similar situations it may compete with *Petromys*.

The occurrence of this rat is easily ascertained, as it closes up the entrances of rock crevices with large masses of small sticks and grass, probably as a protection against enemies, these structures being perforated by tunnels just large enough for them to pass through.

Nocturnal. Feeds largely on the seeds of Kamel-thorn and other leguminous bushes. Not attracted by cultivation."

21. Rattus (Mastomys) coucha A. Sm.

♂. 57, 151, 191–194 (young), 266, 296. ♀. 191, 192 (young), 313, 316. Louisvale.

"Fairly plentiful, but far outnumbered by *Rhabdomys pumilio*, *Tatera*, *Desmodillus*, etc. Nocturnal: attracted by cultivation, and sometimes entering houses. Immature individuals are very different in colour from adults, being dark bluish slate."

22. Mus musculus L.

♂. 135, 235, 241. ♀. 105, 113, 303, 373. Louisvale.

"Fairly plentiful in stores and houses, but, as elsewhere, has not taken to an outdoor existence as it has done in Australia; possibly finding it difficult to compete in this country with the large number of small indigenous rodents.

Imported house rats have not yet found their way to settlements along this part of the river, probably on account of the too recent extension of the railway."

23. Rhabdomys pumilio bechuanæ Thos.

42 specimens. Louisvale. 2600′.

The deep grey Namaqua form *griseus* is readily distinguishable from any of these specimens, but the paler *deserti* of the Kalahari is more doubtfully separable.

Several examples from Louisvale have the hind foot recorded as 27 mm. in length, the same as in the original type, while others have the foot considerably shorter. In colour also there is marked variation in the general tone.

The skulls have unusually heavy supraorbital ridges, and their bullæ are larger than in most forms of the group—about 7·0 mm. in length.

"Diurnal. Particularly plentiful in the vicinity of cultivation, where it probably outnumbered all other small rodents."

24. Thallomys shortridgei, sp. n.

♂. 169, 170 (young). ♀. 1, 180, 181. Louisvale.

"Shot in tree. Arboreal, not occurring away from the wooded area along the river bank. Not plentiful. Mammæ 0–2=4."—G. C. S.

A brown species with very slightly developed face markings.

Size about as in *nigricauda*, or slightly smaller. General colour above brown—near "Brussels brown"—not so greyish as in other species. Under surface white, but the bases of the hairs are mostly slaty; in the type of *nigricauda* they are slaty laterally, white-based centrally, and in *kalaharicus* and the Mossamedes species (*nitela*, see below) they are wholly white. Face grey, but the brown of the crown reaches as far forward as between the eyes. Dark facial markings scarcely developed at all, the darker edges of the orbit quite narrow and inconspicuous, and not extending forwards or backwards as an ocular streak. Ears about of the colour of the head; hairs behind them buffy brown. Hands and feet white, with darker patches on the metapodials. Tail long, black, scarcely so thickly hairy as in *nigricauda*.

Skull with well-marked supraorbital ridges, long palatal foramina, and rather small bullæ, much smaller than in *kalaharicus*, rather smaller than in *nitela*, those of *nigricauda* not known.

Dimensions of the type, measured in the flesh:—

Head and body 150 mm.; tail 189; hind foot 29; ear 22.

Skull: greatest length 35·5; condylo-incisive length 34; zygomatic breadth 18·5; interorbital breadth 5; palatal foramina 8·6; bullæ 6·9; upper molar series (worn) 5·6.

Type. Old female. B.M. No. 23. 5. 9. 156. Original number 180. Collected 2 December, 1922.

This species is distinguishable from *T. nigricauda* by its slaty-based belly hairs, its larger feet, and the marked reduction in the development of the black facial markings.

Capt. Shortridge made special mention of this striking species as being quite new to him, and we have much pleasure in naming it in his honour.

[In working out *Thallomys shortridgei* we have found that the genus would appear to contain six species, which might be arranged as follows:—

A. Black *Eliomys*-like face markings strongly developed.	
a. Bullæ comparatively small, about 7 mm. in length. Angola	1. *T. nitela*, sp. n.
b. Bullæ large, over 8 mm. in length. East Africa	2. *T. loringi* Hell.
B. Black face markings less developed.	
c. Face markings medium.	
a^2. Hairs of chest wholly white, of belly slaty at base. Namaqualand	3. *T. longicauda* Thos.
b^2. Hairs of whole underside white to base. Kalahari	4. *T. kalaharicus* Dollm.
d. Face markings practically absent.	
c^2. Belly hairs slaty based. Orange River.	5. *T. shortridgei* T. & H.
d^2. Belly hairs white at base. E. Africa.	6. *T. scotti*, sp. n.

The teeth of all are of about the same size—5·6–5·9 for the upper series—with the exception of *T. longicauda*, in which this measurement is only about 5·1 mm.

Details of the new species:—

T. nitela, sp. n.

Size comparatively large. Central dorsal area buffy brown. Sides and flanks markedly greyer. Under surface white, the hairs white to their bases. Forehead grey. A strong black facial line running from the side of the muzzle through the eye nearly to the ear. Cheeks grey, but a distinct whitish collar running up from the throat towards the ear. Hands and feet white, with small darker metapodial patches. Tail strongly pencilled, deep black.

Skull with bullæ smaller than in *loringi*, larger than in *shortridgei*.

Dimensions of the type, measured in the flesh :—

Head and body 160 mm.; tail 191; hind foot 30; ear 22.

Skull: front of incisors to back of m^3 18·8; palatal foramina 8·7; upper molar series 5·9.

Hab. Mossamedes. Type from Bomboné, altitude 3200′; other specimens from Ponangkuma 3300′.

Type. Adult male. B.M. No. 9.10.1.49. Original number 17. Collected 11 March, 1906, by Dr. W. J. Ansorge. Six specimens.

A very well-marked species, with its black facial lines, white belly, whitish collar, and bushy black tail.

T. scotti, sp. n.

General colour pale greyish buffy becoming stronger buffy on the rump, sides greyer buffy; under surface sharply defined pure white, the hairs white to their bases. Head grey; facial streaks present, in the form of a blackish clouding round the eyes, but far less developed than in *T. nitela*. Ears with fine buffy hairs and a buffy tuft at their anterior base. An indistinct whitish collar perceptible below ears. Hands and feet white, the latter wholly white, the former with small dark metatarsal patches. Tail as usual greyish brown basally, black for the greater part of its length, not very bushy.

Dimensions of the type, apparently not fully adult :—

Head and body 140 mm.; tail 150; hind foot 24.

Hab. British East Africa; type from the Yata Plains, two days' march East of the Thika River where it joins the Tana. Altitude 4000′.

Type. Immature female. B.M. No. 12.5.19.17. Collected 19 November, 1911 and presented by R. L. Scott, Esq.

By its reduced facial markings and wholly white belly hairs this species is readily distinguishable from the other East African form, *T. loringi*, while its paler general colour is also characteristic.

We have named it in honour of its collector Mr. R. L. Scott, to whom the National Museum owes many important donations.]

"Entirely arboreal, and confined to the tree belt that fringes the Orange River. This belt is liable to partial or complete inundation during the frequent rising of the river, being occasionally under water to a depth of from six to ten feet, at which times these rats must live entirely among the topmost branches of the trees.

Shy, and a very active tree climber. Apparently mainly nocturnal, although occasionally to be seen high up among the branches of trees in the early evenings before sunset, so that during the cold season they may become partly diurnal. Breeding in hollow branches, the entrances to which are guarded by large conspicuous structures of sticks, one of these, which was about fifteen feet from the ground, measuring over six feet in length; while another was built under the roof of a seldom-used Kaffir hut. I did not find this species plentiful, although it is said at times to occur in comparatively large numbers."

25. SACCOSTOMUS HILDÆ Schw.

♂. 59, 161, 182. ♀. 98, 127. Louisvale.

These specimens agree closely with the original series from Kuruman, but our attention has been drawn to the set from Molopo and Lehutitung, in the real Kalahari, determined by Capt. Dollman as *S. anderssoni* de Wint.*, which he distinguishes from *hildæ* by the slightly lighter colour of the adults and much lighter colour of the young, specimens of a similar age being present in both sets.

In this separation we quite agree with him, but not as to the reference of the Kalahari form to the Damaraland species, the difference in colour being in our opinion sufficient for the distinction of the two. We therefore now describe

Saccostomus pagei, sp. n.

General colour above very light, nearly matching Ridgway's "drab-grey," still paler on the sides, much paler and less buffy than in *S. anderssoni*, rather paler than in *S. hildæ*. Half-grown specimens like the adults or even paler, while in *S. hildæ* these are markedly darker than their parents.

Other characters as in *S. hildæ*.

Dimensions of the type, measured in the flesh:—

Head and body 124 mm.; tail 53; hind foot 19; ear 18.

Skull: greatest length 33; condylo-incisive length 31; upper molar series 48.

Hab. Kalahari and Northern Bechuanaland. Type from Lehutitung, 3300′; other specimens from the Molopo River. 3000′.

Type. Adult male. B.M. No. 10. 6. 3. 54. Original number 18. Collected 18 May, 1909, by R. B. Woosnam. Nine specimens.

The striking difference in the colour of the young is the main reason for distinguishing this animal from *S. hildæ*. In *S. anderssoni* the adult is decidedly darker.

We have named this Kalahari species after Mr. John Page, one of the Kaffrarian Museum Trustees, to whom Capt. Shortridge has been very much indebted for help in many ways both in regard to his King William's Town work, and especially in relation to his collecting trip to the Kalahari region.

"Fairly plentiful, but probably owing to the fact that other small rodents occurred in greater numbers in similar localities, not often trapped.

Nocturnal; attracted by cultivation.

* Ann. & Mag. N. H. (8) vi. p. 398, 1910.

This is one of the species that is said occasionally to occur in large quantities. This is a peculiarity of many of the small Karroo rodents, which may in some cases be a migratory movement, but it is equally probable that at times a favourable season, or temporary absence of some plague or enemy, enables them to breed in abnormal numbers."

26. PEDETES CAFER Pall.

♂. 122, 208, 220, 222, 223, 320. ♀. 41, 165, 174, 207, 218, 219, 231. Louisvale.

"Nocturnal. Plentiful around Louisvale, especially near cultivation. Rather stupid and clumsy, and, although somewhat similar to, possessing little of the agility of a Wallaby or even the Australian Kangaroo Rat (*Bettongia*), which perhaps they more resemble in their movements and habits.

Easy to shoot with a lantern at night. Normally, when hunted, they make for the nearest burrow. Their large burrows, which occasionally have an emergency outlet, are usually excavated in open sandy patches."

27. HYSTRIX AFRICÆ-AUSTRALIS Pet.

351. Skull only. Upington district.

Apparently rather rare generally, although probably occurring wherever there are large enough areas of broken rocky country to afford them plenty of cover.

Tracks, shed quills, and old burrows were observed near and below the Augrabies Falls.

28. PETROMYS TYPICUS A. Sm.

♂. 330, 337. ♀. 341. Augrabies Falls, Orange River, 90 miles W. of Upington. 2000′.

♀. 346, 347. Below Augrabies Falls, 100 miles W. of Upington. 1500′.

Comparing this series with the set obtained by Mr. Grant at Klipfontein, Namaqualand, there seems at first sight a good deal of difference in colour, the present series being paler. This difference, however, proves to be due to season, those from Klipfontein having been collected in the winter and those from Augrabies Falls in the summer. Moreover, some of the latter show new hair, as strongly coloured as in the Klipfontein specimens, pushing through the old blackened fur.

"First obtained among hills and rocks at the Augrabies Falls, afterwards in similar localities twelve miles below. Although it was easy to ascertain where they occurred, they did not appear to be particularly plentiful, and were not readily trapped. This may be the eastern limit of their range, although possibly extending as far as a line of rocky hills that runs astride of the river about halfway between Kakamas and Upington. Though previously considered to be entirely diurnal, during the hot season at any rate they become most active towards sunset, while several were caught in traps set overnight.

They creep rather than jump among the rocks, and did not appear to be particularly active. Their habit of filling up the entrances of their hiding places between crevices with a network of sticks resembles that of *Rattus namaquensis*, except that larger and stouter sticks of succulent plants are largely used. *Petromys*, like *Thryonomys*, is a most difficult animal to prepare, the skin being of the consistency of wet blotting-paper. It may be noted that a large area of broken hilly country is often like a forest in that small mammals are generally more numerous among the outside hills and rocks, in the same way that there is more life near the edge of a forest. A female examined contained one young."

29. LEPUS SAXATILIS AURANTII, subsp. n.

♂. 72, 73. ♀. 74, 118. Louisvale. 2600′.

"Not at all confined to rocky country—plentiful around cultivation."—G. C. S.

General characters of ordinary *saxatilis*, the ears not especially lengthened as in the Namaqua subspecies *megalotis*. Colour above, where unbleached, rather paler grey than in true *saxatilis*, but bleaching in summer to a much greater extent, the difference in summer specimens of both very striking. Type with its unbleached hairs "light buff" tipped with black, its bleached areas wholly dull sandy. Crown bleached dull brownish. Throat-band pale greyish buffy.

Skull with very large bullæ, markedly larger than in the longer-eared *megalotis*.

Dimensions of the type, measured in the flesh:—

Head and body 540 mm.; tail 117; hind foot 126; ear 137.

Skull: greatest length 101; condylo-incisive length 89; length of bulla 14.

Type. Old female. B.M. No. 23.5.9.173. Original number 118. Collected 23 November, 1922.

While December specimens of *L. saxatilis* from Central Cape Colony are little paler or more bleached than winter ones, these November examples are all strikingly paler than any specimens of the group that we have seen, whatever time of year they were killed. Such patches of fresh fur as are present are also somewhat paler than occurs in true *saxatilis*. The ears of this form are only of the same length as in true *saxatilis*, not of the extraordinary dimensions of those of *L. s. megalotis*, while on the other hand its bullæ are larger than those of any others of the group.

"Rather plentiful. Attracted by cultivation. Like *Pedetes* easily shot in cultivated ground by night with a lantern, at which times they become dazzled by the light and unusually sluggish in their movements. Sometimes put up by day among thick salt-bush.

Kohl-haas or Rhebok-haas of the Dutch.

Another hare, known locally as Vlack-haas, without doubt a local form of *Lepus capensis*, is reported from this district. It is said to occur in open country and not to be attracted by cultivation. Described as being shy, solitary, and rather rare."

30. Pronolagus crassicaudatus rupestris A. Sm.

♂. 15, 142, 149, 150, 155. ♀. 154. Louisvale. 2600′.
♀. 332. Augrabies Falls. 2000′.

We are now quite convinced that Smith's immature type of *Lepus rupestris* should be referred to the Namaqualand form, to which in 1904 Thomas and Schwann assigned the later name of *Lepus melanurus* Rüpp., the latter being therefore a synonym of the former.

These specimens are more suffused with rufous than most of the examples from Namaqualand, but the difference would appear to be one of season.

"Plentiful where they occur, the range coinciding with that of rocky kopjes and hill ranges, where they are frequently to be found in considerable numbers; otherwise not gregarious to the same degree as a European rabbit. Shy, and rarely appearing before dusk, and even then seldom wandering far from cover. Occasionally the entrances of their hiding places under rocks are protected by an entanglement of sticks and brushwood, but this may indicate breeding places and afford protection for their young. When in the open they are comparatively slow as compared with typical hares, relying more on quickness in dodging behind rocks or under crevices. Often frequenting the same localities as *Procavia capensis*, although many places where they may be numerous will not afford suitable cover for Dassies, which prefer kopjes and other situations where there are abundance of large loose boulders. These rabbits are difficult to prepare, the skin being exceedingly tender, especially on the tail. The fur comes out very easily, and when shot the cloud of fur readily indicates a hit. They are said to pull out large quantities for the purpose of making nests for their young.

Klip-haas or Rooi-haas of the Dutch."

31. Antidorcas euchore Zimm.

♀. 375. Horns only. Upington district.

"Springbuck seldom wander close to the Orange River nowadays in this district, but are said to be still reasonably plentiful in the direction of the Kalahari and elsewhere inland."

32. Oreotragus oreotragus Zimm.

♂. 340. ♀. 345. Augrabies Falls.
♀. 355. Skull only.

"Klipspringers exist in small numbers among the rocky hills and ravines in the vicinity of the Augrabies Falls, and may become more numerous in the hill country still further west.

A pair were put up on one of the islands near the Falls, which crossed over a shallow branch of the river to the mainland when hunted.

I have heard of no other locality eastwards along the river between the Falls and Upington where they occur, although they are said to reappear near Prieska.

The hair of Klipspringers was formerly much in demand among the Boers for stuffing saddles.

Apparently—apart from stragglers—the only other resident buck occurring near the river is the Steinbok. A single individual was observed about twelve miles south of Louisvale. They are well known locally, although not considered plentiful."

33. Hippopotamus amphibius L.

204. Incisor picked up from bed of river near Upington.

"The portion of a tusk sent was picked up in the bed of the Orange River near Louisvale, and presented by Mr. D. Biggs.

Although Hippopotami have long been extinct above the Augrabies Falls, fragments of tusks are not infrequently picked up in or near the river bed.

A small school of Hippo are said to exist in the lower reaches of the Orange River, but as this is a very uninhabited region few authentic reports are available about them.

Cornell, in his fairly recent book, 'The Glamour of Prospecting,' mentions having seen them, so that there is every reason to believe they are still there."

34. Procavia capensis Pall.

♂. 329, 335. ♀. 328, 342. Augrabies Falls. 2000′.
359, 360. Skulls only. Upington district.
361. Skull. Augrabies Falls.
203. Skull. Kopje 12 miles from Louisvale.

"Plentiful among rocks and hills around and below the Augrabies Falls. There are few suitable localities for Rock Dassies near Upington; although a skull was picked up on a large isolated kopje about twelve miles to the south of Louisvale.

Diurnal; but during the hot weather seldom showing themselves except during the early mornings and evenings."

27. The Chondrocranium of the Teleostean Fish *Sebastes marinus*. By N. A. Mackintosh, B.Sc., Demonstrator in Zoology, Imperial College of Science, South Kensington.*

[Received May 8, 1923 : Read June 12, 1923.]

(Text-figures 1–9.)

Contents.

1. Introduction.

The work of Parker and subsequently that of Gaupp, Böker, and others, on the skull of *Salmo*, constitutes the basis of our knowledge of the cranial development of the Teleostomi. Further contributions have been made by Stöhr, McMurrich, Allis, Winslow, Swinnerton, and Pehrson amongst others. In 1910 Allis published a paper dealing in some detail with the cranial anatomy of the mail-cheeked fishes. This paper dealt with the osteology, and to some extent the latero-sensory canals and muscles of the adult cranium, but, so far as I am aware, no work has so far been done on the development of the cartilaginous skull of any of the Scorpænidæ. It is hoped that the present paper will take a step towards meeting this deficiency in that it describes the chondrocranium of a fairly representative member of the group.

The following description is not an exhaustive comparative account, and few generalizations will be made; it deals with the development of the chondrocranium from a very early stage up to the time when the cartilaginous elements of the head are fully developed. Certain comparisons with other forms will be made where points of special interest or peculiarity arise.

The work was undertaken at the suggestion of Prof. MacBride and I wish to take the opportunity of thanking him and Mr. H. G. Cannon for many helpful suggestions.

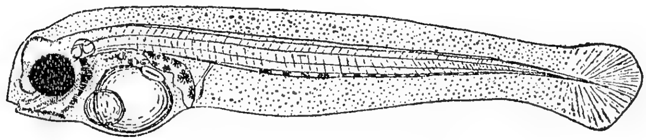
* Communicated by Prof. E. W. MacBride, F.R.S., F.Z.S.

2. Material and Method.

Some difficulty in obtaining all the desirable material has rendered the series of developmental stages a little incomplete, for I was unable to procure any specimens between the 5·5 mm. and 25 mm. stages. This leaves rather a large gap during which a considerable development of cartilage takes place. It is not difficult, however, to reconstruct the more important processes which occur during this period.

I had at my disposal large quantities of specimens from the early segmentation stages up to the 5·5 mm. stage, and three or four specimens ranging between 25 and 30 mms. The abundance early stages compensates to some extent for the lack of some of of the later stages.

Text-figure 1.



Stage 3. External features.

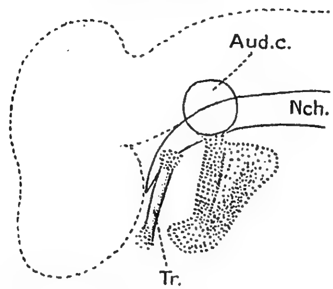
It has been found most convenient to divide the following account into four parts:—

Stage 1. The unhatched embryo.
,, 2. The 4·5 mm. larva.
,, 3. The 5·5 mm. larva.
,, 4. The 25 mm. post-larval stage.

Stages 2 and 3 are close together, but the differences between them are sufficient to justify their separate consideration. The specimens for stages 1–3 were supplied from Lowestoft and those for the 25 mm. stage were supplied by the Board of Fisheries for Scotland at Aberdeen. Fixation was in every case in formalin. Consequently it was not easy to follow much of the histological details of the formation of cartilage, though preservation was otherwise satisfactory. The principal stains used were thionin and orange G, Mallory's triple stain and picronigrosin. For the first stage specimens were removed from the egg capsule for sectioning. The diameter of the curled up embryo is at this stage about 1 mm. The eyes can already be seen with the naked eye and serve as a useful guide for orientation. The 4·5 mm. larva has just escaped from the egg capsule and still retains a large yolk sac. In most respects it closely resembles the 5·5 mm. larva. In the latter (text-fig. 1) the yolk sac is considerably reduced though it is still a fairly substantial body. The principal features of this larva are the very long tail, the large eyes, and the distinct cranial flexure. The mouth is still in a more or less ventral position, but has shifted further forward than in the 4·5 mm. stage. The auditory vesicles are fairly well advanced and can be seen clearly in whole mounts. Large pigment cells are to be seen over the posterior part of the gut, and there is a row along the ventral side of the tail. The 25 mm. specimens are of a post-larval stage and exhibit roughly the form of the adult.

Reconstructions were in each case made from series of transverse sections cut at 10 μ. These were examined with the aid of a squared eyepiece micrometer, and lateral and dorsal views were plotted directly on to squared paper. The details of this method are described in a recent paper by Wells (1922) on the chondrocranium of *Clupea*. As it is necessary in this method to have a

Text-figure 2.



Stage 1. Lateral view of chondrocranium.

base line from which all measurements are made it is usual to assume that some element in the head, generally the notochord or some piece of cartilage, is straight. I have been able to avoid this assumption by plotting an accurate outline of the head before sectioning it, and then taking all measurements from the outline. Other methods of reconstruction are described by Norman (1923) in a paper dealing specially with the subject.

3. The Chondrocranium

a. *Stage* 1. *The unhatched embryo.*

This is the earliest stage it was found profitable to investigate (text-fig. 2). The head skeleton is in an extremely elementary condition, and is represented principally by tracts of procartilage and connective-tissue cells which are becoming concentrated into the positions in which cartilage is subsequently to be laid down. It is always a matter of some difficulty to draw a definite line between procartilage and cartilage proper. The trabeculæ at this stage appear to be in an intermediate condition. The outline is quite definite, but the cells have not become thoroughly welded together to form a solid matrix. The trabeculæ are very short paired rods, ending freely at both ends and lying just below the apex of the notochord and behind the forebrain. There is a marked cranial flexure. At present there is no sign of the parachordals.

The visceral skeleton is represented by a relatively extensive but barely differentiated mass of procartilage. In this it is possible to distinguish on each side an element running downwards from the auditory vesicle. This element ultimately gives rise to the jaw suspension apparatus. At the foot of it the procartilage runs forwards for a short distance indicating the position in which Meckel's cartilage is to be laid down. This cartilage appears later as a condensation on each side which grows forwards as the cranial flexure is eased and the mouth moves forwards. At the present stage the mouth has not appeared. The rest of the mass of procartilage extends upwards and backwards and constitutes the rudiments of the branchial bars.

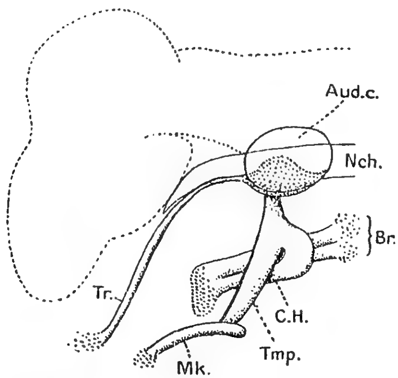
b. *Stage* 2. *The* 4·5 *mm. larva.*

The trabeculæ have at this stage lengthened considerably (text-fig. 3) and form a roof to the mouth, which has now made its appearance. The parachordals are now established and are continuous with the trabeculæ, but where they form the floor of the auditory capsule they are in a procartilaginous condition. They cannot, however, be distinguished as anterior and posterior plates as in the case of *Salmo*, *Gasterosteus*, etc. The trabeculæ are closely approximated along the whole of their length and end freely anteriorly, though there is at their extremity a condensation of connective tissue representing the ethmoid plate. The notochord reaches well forward and turns down under the rudiment of the infundibulum.

In the visceral skeleton Meckel's cartilage has made its appearance, its two components being joined anteriorly by a tract of procartilage. A substantial bar of cartilage articulates with the lower jaw near its posterior end and with the lower surface of the auditory capsule. This element, which appears to be a piece of continuous cartilage, later gives rise to the hyomandibular, symplectic, and quadrate cartilages. Pouchet (1878) employed the term "primordial temporal" to a somewhat similar element which he found in certain forms. As "temporal" is now obsolete as an alternative name for the hyomandibular, and as I am unaware of any name at present in use which could rightly be applied to the bar which, in *Sebastes*, joins the lower jaw to the auditory capsule, I propose for convenience to call it the temporal cartilage. From the posterior side of this temporal cartilage a branch is given off which turns inwards and forwards as the ceratohyal to join the anterior end of a mass of cartilage from which the branchial bars are beginning to be differentiated. The point at which the ceratohyal branches off is composed of rather immature cartilage which later becomes more compact and forms the stylohyal.

A remarkable feature which has become evident at this stage is the precocious development of the visceral skeleton. The lower jaw, temporal, ceratohyal, and to some extent the first two branchial bars are all distinguishable, while the cranium consists only of the simple parallel trabeculæ and the barely established parachordals. It is interesting at this point to note in connection with the form assumed by the parachordals that Filatoff (1916) has shown that if the auditory vesicle of *Bufo* is transplanted to a position overlying the trabeculæ a cartilaginous capsule tends to

Text-figure 3.



Stage 2. Lateral view of chondrocranium.

form round it, while the parachordals from which the vesicle has been removed do not form a capsule. It is pointed out that the formation of the cartilaginous capsule is not an inherent property of the parachordals, but depends upon the presence of the vesicle.

From now onwards the mouth tends to move forwards and upwards, and Meckel's cartilage follows it by growth at the anterior end.

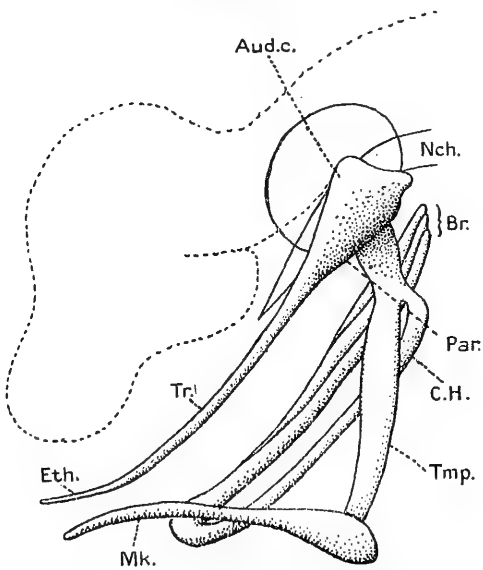
c. *Stage* 3. *The* 5·5 *mm. larva.*

The trabeculæ have still further lengthened and are now joined anteriorly in an extensive but very thin ethmoid plate (text-fig. 5) which as yet shows no sign of any of the upgrowths which later form the investment of the olfactory organs. According to Gaupp it has been shown that in *Salmo salar* the cartilage of the ethmoid plate is formed from the epithelium lining the roof of the mouth, and is therefore ectodermal in origin. In *Sebastes* at this stage it can still be seen from the structure of the ethmoid plate that it is formed from a single layer of cells. But a study of the 4·5 mm. stage shows that these cells are derived from a local condensation of connective tissue.

The notochord still reaches well forward and maintains a marked flexure (text-fig. 4). Another peculiarity to be mentioned here is that there is no sign of a fenestra hypophyseos which is normally present in a tropibasic chondrocranium at this stage. The trabeculæ are still closely approximated along the whole of their length. The parachordals are now well developed and form broad, saucer-shaped bases to the auditory vesicles.

The visceral skeleton has maintained its advance over the cranial elements. The lower jaw has now attained a considerable length, but there is still no vestige of an upper jaw. In this peculiarity the development resembles that of the larval *Clupea*

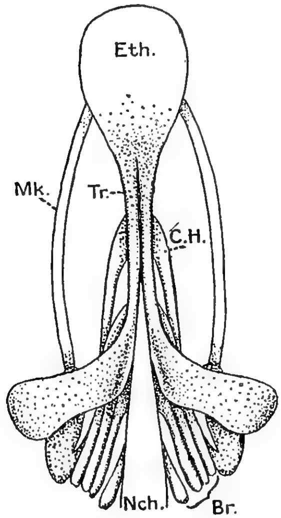
Text-figure 4.



Stage 3. Lateral view of chondrocranium.

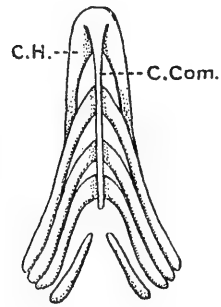
(Wells, 1922) in which the upper jaw does not appear until the 13 mm. stage. The temporal cartilage (text-fig. 4) has lengthened, but has otherwise undergone no change except for the fact that the hyomandibular portion is better defined. There is at present no foramen for the hyomandibular branch of the VIIth nerve. It appears that the nerve becomes enclosed in the cartilage later on. The cartilage joining the ceratohyal to the temporal is now constricted to a narrow stylohyal. Considerable development has taken place in the branchial bars (text-fig. 6). There is a median copula communis to which the ceratohyal and the first three branchial bars are attached. The fourth bar is free and the fifth has not yet appeared. The branchial bars occupy a rather advanced position. They form a kind of ridge on the floor of the mouth, the copula communis being at a higher level than the gill-

Text-figure 5.



Stage 3. Dorsal view of chondrocranium.

Text-figure 6.



Stage 3. Dorsal view of branchial bars.

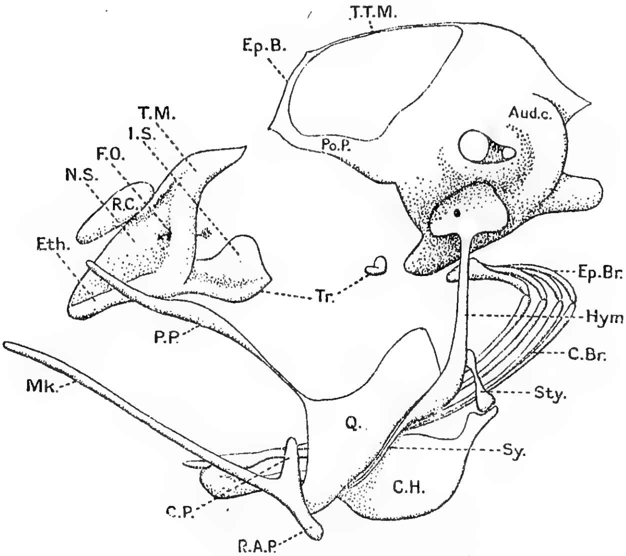
bars which slope downwards and backwards in relation to it. The interior of the mouth is thus in the form of an inverted V when viewed in transverse section.

d. *Stage* 4. *The* 25 *mm. Stage.*

The chondrocranium may now be looked on as fairly complete (text-figs. 7, 8, and 9). A certain amount of ossification has taken place. As already mentioned I was unable to procure any specimens between this and the 5·5 mm. stage, and at first glance it would seem that the gap is so large that it would be a matter of difficulty to connect the two stages with any profit. However, by a careful study of the complete chondrocranium and by analogy with the changes which take place in other forms, it is possible to reconstruct from a general point of view the processes which bring about the conditions found in the present stage.

The ethmoid region of the mature chondrocranium of *Sebastes* (text-fig. 7) bears a strong resemblance to that of *Salmo*, and there can be little doubt that it arises in much the same manner. In the 25 mm. stage it consists of a substantial mass of cartilage roughly triangular in shape when viewed from the side. The base of this triangle consists of a thickened plate representing the originally thin ethmoid plate. Above and continuous with this lies the nasal septum which expands posteriorly to form a vertical pillar, the antorbital planum. The upper part of the antorbital planum turns backwards in the form of two lateral horns, the tæniæ marginales (text-fig. 8) approaching the extremities of the epiphysial bar and postorbital processes presently to be described. The antorbital planum is pierced on either side by the foramen for the olfactory nerve. The ethmoid structure has evidently arisen from a median ridge and posterior upgrowth on the ethmoid plate, the former giving rise to the nasal septum and the latter to the antorbital planum. It is probable that at a slightly

Text-figure 7.



Stage 4. Lateral view of chondrocranium.

earlier stage the tæniæ marginales were connected with the epiphysial bar, and afterwards became separated as is the case in *Gasterosteus* (Swinnerton, 1902). This point will be referred to again later.

The fused trabeculæ are now hardly recognisable as such. They are represented by two median pieces of cartilage, one of which is attached to the ethmoid region while the other is a small piece of free cartilage level with the posterior border of the eye. The former remnant of the trabeculæ consists of a thickened base resulting from the fusion of the two originally separate elements, bearing a plate-like upgrowth which constitutes an interorbital septum. This fragmentation of the trabeculæ is not uncommon in Teleosts. A somewhat similar process takes place in *Cyclopterus* (Uhlmann, 1921).

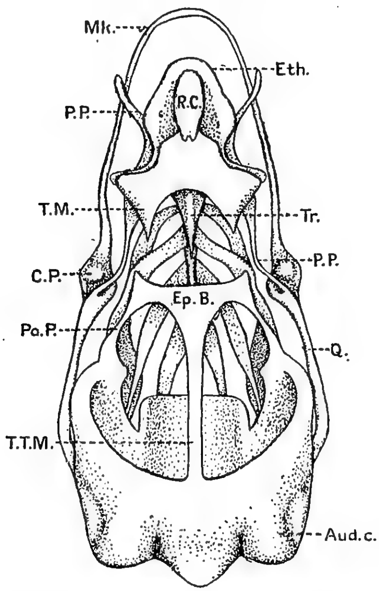
Above the nasal septum lies a slightly elongated rostral cartilage. It shows no connection either with the ethmoid or palatine cartilages.

The parachordals have given rise to a substantial investment of the auditory capsules and posterior part of the brain. The notochord has retreated considerably relative to the auditory capsules, and is now bridged over by cartilage. Below and in front of the articulation of the hyomandibular with the auditory capsule a process projects forwards on either side. These probably represent the anterior part of the parachordals. The trigeminal nerve passes out through a notch above them. The auditory capsules are now completely enclosed and the cartilage is continued as a roof over the hinder part of the brain. From the side wall of the brain there runs forward on each side a postorbital process which joins the ends of a transverse bridge, the epiphysial bar. This bar (text-fig. 8) cuts off the posterior dorsal fontanelle, and the fontanelle is divided into lateral halves by a tænia tectum medialis, a thin band of cartilage joining the epiphysial bar with the posterior covering of the cranial cavity. In *Salmo*, *Amia* (Pehrson, 1922), and others the epiphysial bar, being connected also with the tæniæ marginales, forms in addition an anterior dorsal fontanelle which gradually fills up. This anterior roofing in does not occur in *Sebastes*. In *Amiurus* (Kindred, 1919) a permanent anterior fontanelle is formed which, however, does not close up, while in *Gasterosteus* the fontanelle is formed, but the epiphysial cartilage, as is probably the case in *Sebastes*, becomes disconnected from the ethmoid region.

It is now necessary to consider how the cranial elements developed from the parachordals have arisen. It is obvious that there has been a vigorous upward growth from the edges of the cartilage which in the 5·5 mm. stage formed the base of the auditory capsule. This growth has extended so far as to roof over the posterior part of the cranial cavity. The postorbital processes have evidently grown forwards from the lateral walls of the cranium, but it is difficult to say whether the epiphysial bar has arisen independently or whether it has been formed by the joining together of processes growing upward from the ends of the postorbital processes. Independent formation is the more common condition among Teleosts. The tænia tectum medialis is probably a backward growth from the epiphysial bar. This is how it is formed in *Cyclopterus*, and in *Sebastes* the anterior part of the band is broad and strong while the posterior part is very thin and frail.

The changes undergone by the jaw arches and visceral skeleton are almost as great as these displayed by the cranium. The lower jaw is a long, rod-like cartilage bearing coronoid and retro-articular processes at the point of its articulation with the quadrate. In this respect it resembles the lower jaw of *Amia*. In place of the temporal cartilage we have now the clearly differentiated hyomandibular, symplectic, and quadrate. The hyomandibular presents a rather unusual appearance. It is club-shaped and very long. At its point of articulation with the auditory capsule it has a broad plate-like head which is continued downwards as a comparatively slender stem merging into the symplectic. The latter is also rather longer than usual and runs down close to the lower margin of the quadrate. This is a very large plate of cartilage extended upward and backward as a metapterygoid process. Posteriorly the quadrate is in intimate association with

Text-figure 8.



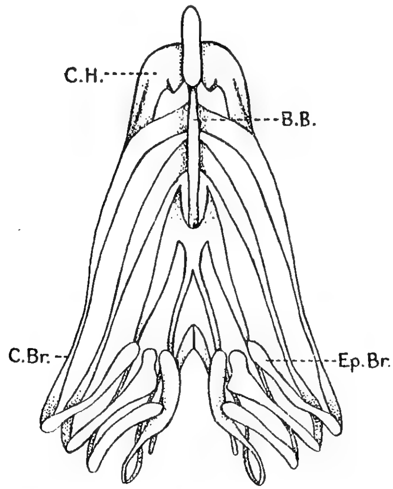
Stage 4. Dorsal view of chondrocranium.

the symplectic but is not continuous with it. The upper jaw, consisting of the palato-pterygoid cartilage, is now established and runs from the upper anterior angle of the quadrate up to a point level with the anterior end of the rostral cartilage. The posterior end of the palato-pterygoid is very slender. It passes close to the margin of the ethmoid plate but is not articulated with it. At its extremity it turns outwards (text-fig. 8), reaching almost to the surface of the snout.

The fact that the upper jaw is connected with the quadrate only by a very slender piece of cartilage suggests that it may have arisen independently and grown back to meet the dorso-anterior angle of the quadrate. This supposition is strengthened by a comparison with the conditions found in the chondrocranium of the larval *Clupea*, in which the upper jaw also arises at a late stage and grows back to join the quadrate in a slender connection. A somewhat similar process occurs in *Amiurus* and *Syngnathus*, in each of which the palatine arises separately.

It appears that the quadrate, symplectic, and hyomandibular have all arisen from the original temporal cartilage. In such a case it might be expected that the three elements were formed separately in the earliest stages, then became fused to form the temporal and finally separated again. In studying the earliest stages in which the temporal can be distinguished I have not been able to trace any division. But in these early stages the

Text-figure 9.



Stage 4. Dorsal view of branchial bars.

cartilage is in an immature condition, and it is very hard always to be certain whether it is continuous or not. It would also be difficult to reconstruct the details of the process by which the differentiation of the hyomandibular, symplectic, and quadrate has come about. It is worth noting that in the 5·5 mm. stage the hyomandibular part of the temporal is very short and that it has become greatly lengthened in the intervening period. The long hyomandibular is a feature correlated with the rather unusual depth of the head in the adult *Sebastes*.

The stylohyal is now a small cartilage articulated with the hyomandibular and ceratohyal. The latter is in the form of a very large plate bearing a posterior process for the articulation with the stylohyal. The anterior part of the ceratohyal tends to become more rod-like. It is possible that the expansive form of the ceratohyal is correlated with the fact that the gill-bars reach far forward, in that its position suggests that it serves as a protection to the anterior parts of the bars, the posterior parts being of course protected later by the development of the opercular bones. The anterior junction of the ceratohyals is surmounted by a short tongue of cartilage, and there passes back a median bar, the basi-branchial, corresponding to the copula communis (text-fig. 9). To this bar are attached the first four branchials. The fifth pair are free but articulate with one another at their bases. The third pair is peculiar in that the base of each is produced forwards in two downwardly directed processes. The ceratobranchials are very long and fairly stout near their articulation with the basibranchial; further back they become very slender, but before meeting the epibranchials they become thicker again. Perhaps the most important development of the branchial elements lies in the appearance of the epibranchials. These are possessed by the first four bars but not by the fifth. They are short in comparison with the ceratobranchials and of a slightly irregular, twisted shape.

Here again it is difficult to fill in any details during the preceding period of development. This, however, is not of great importance as the branchial bars have not undergone any striking changes beyond the addition of the fifth bar, the epibranchials, and a few subsidiary elements.

4. Summary.

1. There is a precocious development of the visceral skeleton.
2. In at least the earlier stages there is no sign of a fenestra hypophyseos.
3. The cranial flexure is retained for a considerable period after hatching.
4. In the 5·5 mm. stage the hyomandibular, symplectic, and quadrate are represented by a simple temporal cartilage. This appears also to be a single piece of cartilage in the earlier stages.
5. The upper jaw does not appear until a comparatively late stage, and there is evidence that it arises independently and grows back to meet the quadrate.
6. The anterior part of the trabeculæ gives rise to an interorbital septum of rather limited area.
7. There is a free rostral cartilage situated above the nasal septum.
8. The lower jaw is long and exhibits prominent coronoid and retro-articular processes.
9. The hyomandibular is club-shaped and very long. Its length is correlated with the special depth of the head.

5. Abbreviations.

Aud.c.	Auditory capsule.	Nch.	Notochord.
B.B.	Basibranchial.	N.S.	Nasal septum.
Br.	Branchial bars.	Par.	Parachordals.
C.Br.	Ceratobranchials.	P.P.	Palato-pterygoid.
C.Com.	Copula communis.	Po.P.	Postorbital process.
C.H.	Ceratohyal.	Q.	Quadrate.
C.P.	Coronoid process.	RAP.	Retro-articular process.
Ep.B.	Epiphysial bar.	RC.	Rostral cartilage.
Ep.Br.	Epibranchials.	Sty.	Stylohyal.
Eth.	Ethmoid plate.	Sy.	Symplectic.
F.O.	Olfactory foramen.	Tmp.	Temporal.
Hym.	Hyomandibular.	T.M.	Tænia marginalis.
I.S.	Interorbital septum.	T.T.M.	Tænia tectum medialis.
Mk.	Meckel's cartilage.	Tr.	Trabeculæ.

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28. The Comparative Anatomy of the Tongues of the Mammalia.—IX. Edentata, Dermoptera, and Insectivora.

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(Text-figures 50–57.)

CONTENTS.

Order EDENTATA.

The tongues of the Edentata are characterised by a high degree of specialisation of their extrinsic muscles, and by a slight or moderate development of their glands and gustatory organs. Their mobility is greater than that of all other Mammalian tongues except those of *Zaglossus* and *Acanthoglossus*. In the Myrmecophagidæ and Manidæ the mobility is designed mainly for the purposes of prehension; but in other Edentates prehension is combined with a mechanical action of the food.

Form, Apex and Lateral Borders:—The tongue is long, vermiform and not flattened anteriorly in the Myrmecophagidæ (text-fig. 50); it is cylindrical posteriorly and flattened anteriorly in the Manidæ (text-fig. 52); it is long, flat and triangular in the Dasypodidæ and *Orycteropus* (text-fig. 52); and it is short, with the usual Mammalian form in the Bradypodidæ*.

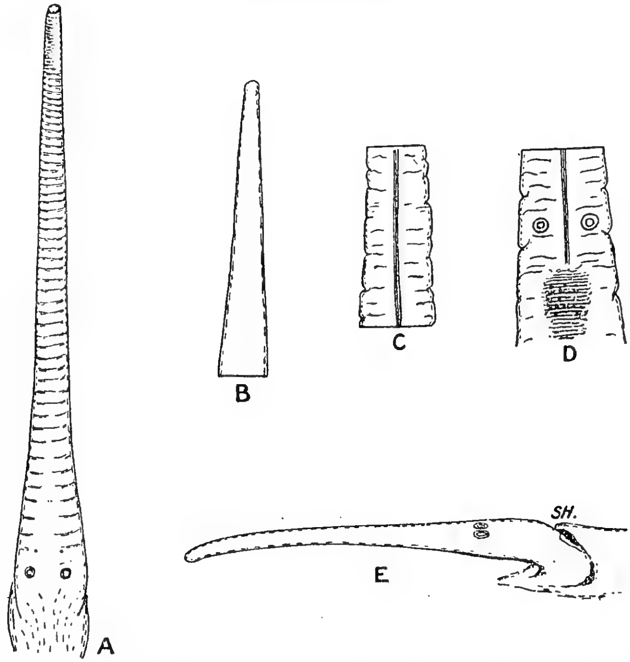
The apex is rounded in the Bradypodidæ; it is pointed in *Orycteropus*; and it bears peculiar globular or pointed organs in the other Edentates. These take the form of globular expansions of the whole apex in the Myrmecophagidæ and Dasypodidæ, or of a button-like structure attached to the centre of the apex in the Manidæ (text-figs. 50 and 52). No trace of this terminal swelling is present in the Bradypodidæ and *Orycteropus*. I was unable to examine the swellings microscopically to settle their nature, as the tongues are preserved in the Museum of the Royal College of Surgeons. Some authors regard them as sense organs, and Mayer (**14**) described the swelling in *Myrmecophaga* as gustatory in function. Perhaps

* See text-fig. 10 in my paper on the anatomy of Bradypus (**26**).

they are allied to the marginal lobes in *Galeopithecus*, the Pinnipedia and Cetacea.

Mayer (**14**) described two small sharp processes, with their ends directed forwards and inwards, beneath the apex of the tongue of *Dasypus peba*, *D. decem-*, *D. novem-*, and *D. octocinctus*. They receive prolongations of the lingual musculature. Their function is probably to capture and grip food, and Mayer thought they might open and close and be useful for killing insects.

Text-figure 50.



The tongues of the Myrmecophagidæ. A: *Tamandua tetradactyla*; B.C.D: the front, middle, and back of the dorsum in *Myrmecophaga jubata*; E: side view of the tongue in *Myrmecophaga* showing the sheath (SH.) for the tongue.

The lateral borders are not distinguishable on those tongues which are cylindrical throughout (*Myrmecophaga*, *Tamandua*, *Cyclothurus*). In *Manis* the flattened anterior part has a pronounced edge, but the posterior cylindrical part has no distinct edge. In the Dasypodidæ and *Orycteropus* the lateral borders are pronounced and moderately thick, but the Bradypodidæ have borders of considerable vertical depth. Lateral organs are only found in some specimens of *Dasypus*.

Sulci and Ridges:—Median dorsal sulci are found in *Manis*, *Myrmecophaga* and *Orycteropus*. In *Manis* (text-fig. 52) there is a wide, shallow groove on the flattened anterior part of the tongue. In *Orycteropus* (text-fig. 52) a fine groove runs along the greater part of the dorsum. And in *Myrmecophaga* (text-fig. 50) there is a shallow groove behind the circumvallate papillæ; when it is traced forwards it merges into a central strip of the tongue in which the mucosa is thrown into transverse folds. Numerous fine transverse sulci are found in these animals and in *Tamandua* and *Cyclothurus*.

Median ridges are present on the inferior surface of the tongue in *Orycteropus* and *Tatusia*. In the former (text-fig. 52) there are three ridges and many transverse sulci; in the latter there is a single ridge.

In the case of Edentates with long, vermiform, protrusible tongues there are sheaths into which they can be retracted. In text-fig. 52 is shown a corrugated cuff-like sheath in *Manis*.

Circumvallate Papillæ:—The following list summarises the observations made by myself and those recorded by others:—

Family MYRMECOPHAGIDÆ.

Myrmecophaga jubata: 2 vallate papillæ (Flower, **8**; and self).
,, *didactyla*: 2 vallate papillæ (Carus and Otto, **4**).
Tamandua tetradactyla: 2 vallate papillæ (Mayer, **14**; Münch, **16**)
Cyclothurus: 2 vallate papillæ.

Family DASYPODIDÆ.

Podwisotzky (**19**) showed how all species have two vallate papillæ, and this has been confirmed by observations of many authors on all known species of *Dasypus*, *Tatusia* and *Tolypeutes*. The records have been collected by Oppel (**17**).

Family BRADYPODIDÆ.

Bradypus tridactylus: 2 vallate papillæ (Cuvier, **6**; Sonntag, **25**).
,, ,, : 3 vallate papillæ (Mayer, **14**).
,, ,, : 2 vallate papillæ (Mayer, **14**).
,, *cuculliger*: 2 vallate papillæ (Brücher, **2**).
Cholœpus didactylus: 2 vallate papillæ.
Chlamydophorus truncatus: 2 vallate papillæ (Tuckerman, **21**).

Family MANIDÆ.

Manis pentadactyla: 3 vallate papillæ in a triangle (Carus and Otto, **4**).
,, *tetradactyla*: 3 vallate papillæ in a triangle (Mayer, **14**).
,, ,, : 2 vallate papillæ (Carus and Otto, **4**).
,, *javanica*: 3 vallate papillæ in a triangle.
,, ,, : 3 vallate papillæ in a triangle (Oppel).

Family Orycteropodidæ.

Orycteropus capensis: 3 vallate papillæ in a triangle.
,, ,, : 3 vallate papillæ (Rapp, **20**).

It is thus evident that with very few exceptions the American Edentates have a pair of circumvallate papillæ, whereas the African forms have three papillæ disposed in a triangle with the apex directed backwards.

The papillæ are frequently found retracted within a deep fossa, but those in some of the Dasypodidæ stand up very prominently. In the specimen of *Tatusia* shown in text-fig. 51 they are very prominent, and it is at first sight difficult to distinguish them from the larger fungiform papillæ on the posterior part of the oral division of the dorsum.

The vallate papillæ are close to the epiglottis in the Bradypodidæ, Dasypodidæ, Myrmecophagidæ and *Orycteropus*, but they lie far from it in *Manis*, thus making the basal part of the tongue long.

In *Tamandua* (text-fig. 50) there are two small pin-hole-like pits in front of the vallate papillæ, but I was unable to make a histological examination to ascertain whether or not they receive the secretions of glands.

The vallate papillæ are circular on plan, and cylindrical or conical on elevation, with the apex of the cone attached to the tongue. The surface is smooth or granular, and a histological examination shows that the granular effect is produced by several secondary papillæ. The fossa is well marked, and the vallum frequently overlaps the edge of the papillæ. Oppel (**17**) has published an illustration of a section through a papilla in *Manis javanica*, showing how the long axes of the taste-buds run downwards and outwards towards the fossa which passes under the base of the cone-like papillæ.

Tuckerman (**21**) pointed out that the papillæ in *Dasypus peba* resemble those of the higher Mammalia, but those of *Chlamydophorus truncatus* are very similar to those of the Marsupialia; their resemblance to the anterior papillæ in *Belideus* and *Phalangista* is very marked indeed.

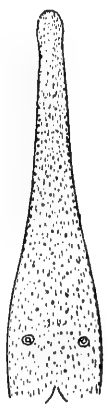
Fungiform Papillæ:—I did not observe any trace of fungiform papillæ in *Myrmecophaga*, *Tamandua*, *Cyclothurus* or *Manis*, nor has any other anatomist described them. They are present in all other Edentata, but they are never very numerous. No apical cluster exists, but they have the usual arrangement in rows of varying degrees of obliquity behind that in the Dasypodidæ; and they stretch right across the dorsum (text-fig. 51). In the Bradypodidæ* the apical cluster varies in size, but the papillæ do not cross the middle line. In *Orycteropus* there is no apical cluster, and the papillæ only form a dorsal bounding zone. Tuckerman (**21**) points out that some of the papillæ are sunk in

* See foot-note on page 515.

little hollows in *Dasypus peba*; and those lying on the posterior part of the tongue have well-developed taste-buds. No papillæ fungiformes are present on the lateral borders.

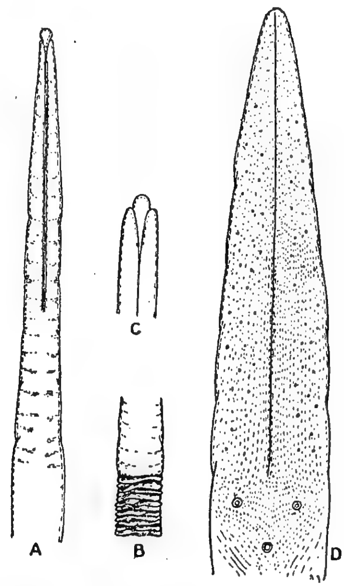
Lateral Organs:—There appears to be considerable variation in the lateral organs, for the views of various authors are conflicting. I observed no trace of organs in *Myrmecophaga jubata*, *Tamandua tetradactyla*, *Cyclothurus didactylus*, *Manis* (sp. ?), *Orycteropus capensis*, *Bradypus tridactylus*, *Tatusia* (sp. ?) and *Dasypus villosus*. Mayer (**14**) observed them in *Myrmecophaga* and the Dasypodidæ. Boulart (**1**) and Tuckerman (**21**)

Text-figure 51.



The tongue of *Tatusia*.

Text-figure 52.



The tongues of the Manidæ. A.B: front and back of the tongue of *Manis*; C: under surface of the apex of the tongue of *Manis*; D: the tongue of *Orycteropus capensis*.

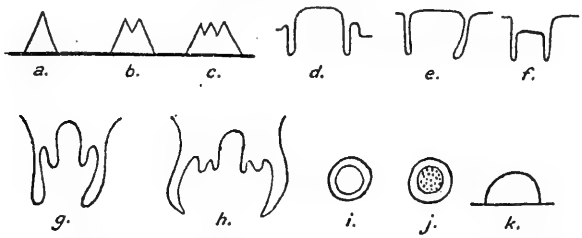
found them in *Tatusia*, and the latter author found them taking the form of minute openings in several Armadillos; taste-buds and serous glands were connected to them. Gmelin (**9**) found no trace of organs in *Orycteropus*, the Armadillos and Sloths, and Podwisotzky (**19**) saw them in *Dasypus sexcinctus*. So it is evident that the organs are variable in the Dasypodidæ, but usually absent in the other Edentates.

Conical Papillæ:—These papillæ are well-marked in the Bradypodidæ, Dasypodidæ and *Orycteropus*, but I found no trace of them on naked-eye examination in the Myrmecophagidæ or

Manis. In the species in which I observed them they have the usual arrangement in an apical cluster, and in rows of varying degrees of obliquity behind that. They are also present on the lateral borders, but they are restricted to a narrow bounding zone on the inferior surface of the tongue. They stretch back to the neighbourhood of the epiglottis, but those on the base of the tongue are not very large. In *Orycteropus* (text-fig. 52) the individual papillæ are easily distinguished; in the Bradypodidæ they can only be detected through a lens; and in the Dasypodidæ they vary in prominence to such a degree that the dorsum appears granular (*Dasypus*) or almost shaggy (*Tatusia*). Some of the types of conical papillæ in the Dasypodidæ and Bradypodidæ are shown in text-fig. 53.

Oppel (**17**) described scanty conical papillæ in *Manis,* and Tuckerman (**21**) stated that those in *Dasypus villosus* are intermediate in character between the coronate and fasciculate papillæ in Marsupials and the mechanical papillæ in higher Mammalia. Secondary papillæ are found on many of the main ones.

Text-figure 53.



The papillæ in the Edentata. *a–c*: conical papillæ; *d–h*: circumvallate papillæ cut vertically; *i–k*: fungiform papillæ.

Glands:—Oppel (**17**) and Podwisotzky (**19**) mapped out the serous and mucous glands of the tongue in *Manis javanica.* They showed that the mucous glands form a cluster on the base of the tongue, whilst the patch of serous glands lies far forwards round the vallate papillæ. Owing to the large size of the salivary glands the mucous glands are not very numerous. I did not observe any patulous glandular orifices in the Myrmecophagidæ or Orycteropodidæ. In the specimen of *Manis* at my disposal the base of the tongue was concealed to a considerable extent by the sheath. But in *Bradypus* I observed a number of orifices and lymphoid nodules. No apical gland of Nuhn is present.

The serous glands vary in the Dasypodidæ; they are numerous in *Dasypus villosus*, but scanty in *D. peba.*

Lytta:—The only Edentates which possess a lytta are *Manis gigas* and *M. javanica.* It has been described and figured by Oppel (**17**) and Rapp (**20**); and Mayer (**14**) points out that it is large as in many Carnivora. I was unable to cut into the tongues of *Manis*, *Myrmecophaga* or *Orycteropus*, but I found no trace of it in *Tamandua*, *Bradypus*, *Dasypus* or *Tatusia*.

The *frenum* is short in all Edentates.

There is no trace of plicæ fimbriatæ or frenal lamellæ. The musculature and elastic tissue have already been fully described by Owen (18) and others. No intermolar eminence is present.

Sir William Flower (27) came to the following conclusions as regards the affinities of the Edentates:—"All the American Edentates at present known, however diversified in form and habits, belong to a common stock. The *Bradypodidæ*, *Megatheriidæ*, and *Myrmecophagidæ* are closely allied, the modifications seen in existing families relating to food and manner of life. The ancestral forms may have been omnivorous, like the present Armadillos, and gradually separated into the purely vegetable and purely animal feeders; from the former are developed the modern Sloths, from the latter the Anteaters. The Armadillos are another modification of the same type, retaining some more generalised features, as those of the alimentary organs, but in other respects, as their defensive armature, remarkably specialised.

"The two Old-World forms *Manidæ* and *Orycteropidæ* are so essentially distinct from all the American families, that it may even be considered doubtful whether they are derived from the same primary branch of mammals, or whether they may not be offsets from some other branch, the remaining members of which have been lost to knowledge."

It was shown above that the tongues of the American Edentates have two circumvallate papillæ, whereas those of the Old-World forms have three; and it is only in rare specimens that this arrangement is departed from.

If the Armadillos were like the ancestral forms, as Flower believed them to be, it is necessary to see whether their tongues could have been transformed into those of the Myrmecophagidæ and Bradypodidæ. The tongue of any Armadillo is long and triangular, with a slightly bulbous apex and a good supply of fungiform and conical papillæ; and in some species there are lateral organs. If the tongue be simply shortened, with loss by absorption of the apical swelling, it would become indistinguishable from that of *Bradypus*. Conversely, enormous elongation of the tongue, with retention and specialisation of the apical swelling, produces a tongue like that of *Tamandua* or *Myrmecophaga*; and as the tongue in these insectivorous animals is merely a glutinous finger, the conical and fungiform papillæ on the dorsum would undergo disuse atrophy. So it is evident that the mere changes in form, with or without disuse atrophy, would convert the tongue of an Armadillo into that of a Sloth or an Anteater.

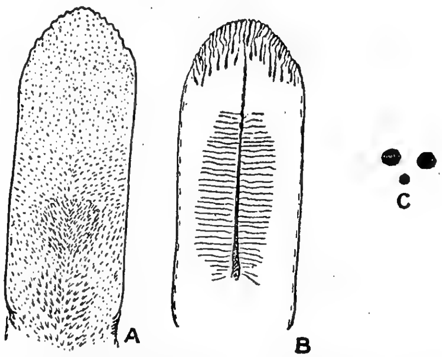
The tongue of *Manis* resembles those of the Myrmecophagidæ in its general form, and in the specialisation of the apex to form a sensory organ; but the likeness between them stops there.

These resemblances are the result of convergence and are, consequently, no test of affinity. There is, moreover, no resemblance between the tongues of *Manis* and *Orycteropus*, beyond the characters of the circumvallate papillæ. If they have arisen from a common form, the great contrast between them is the result of adaptation to a particular diet and mode of feeding. And there appears to be no affinity between the tongues of the African and American Edentates. So it is evident that the characters of the tongues lend additional support to Flower's views on the mutual affinities of the Edentata.

Order DERMOPTERA.

The tongue of *Galeopithecus volans* (text-fig. 54) is long, narrow and thick, and its free part is of considerable extent. The upper surface is chocolate-coloured, but the lower surface is pale. The *apex* is rounded, devoid of a notch, and divided into lobules by fissures, which pass backwards and inwards for a considerable distance on the inferior surface. The *lateral borders* are full and rounded, and have well-marked lateral organs at their posterior extremities. A well-marked *median dorsal sulcus* runs back along the greater part of the oral division of the

Text-figure 54.



The tongue of *Galeopithecus volans*. A: dorsum; B: under surface; C: vallate papillæ of a second specimen.

dorsum, but no transverse fissures diverge from it. The *median ventral sulcus* is equally well-marked, and transverse sulci diverge from its posterior part. There is no trace of a foramen cæcum or plicæ fimbriatæ, and the frenum is very short. No frenal lamella is present.

Papillæ:—The whole of the dorsum from the apex back to the epiglottis is covered with thickly-set, sharp, hard conical papillæ which have the usual arrangement in clusters and rows; and they increase in size from within outwards, and from before backwards. They also cover the upper part of the lateral borders, but they are not present on the inferior surface of the tongue. They are of a simple character. In one tongue I was unable to detect any circumvallate or fungiform papillæ; but these were probably buried under the conical papillæ. In a second tongue the conical papillæ were short, the fungiform papillæ were scanty, but had the usual arrangement; and there were two large vallate papillæ, with a minute one in between.

Lateral Organs:—Owing to the great length of the oral part of the tongue, the lateral organs appear to be placed far back on the lateral borders. They are as well marked as those in Primates: and each consists of eleven laminæ separated by deep sulci.

Sublingua:—Gregory (**10**) pointed out the *Galeopithecus* has a sublingua similar to that in *Tupaia*, but I was unable to detect either a sublingua or plicæ fimbriatæ in three tongues.

No lytta is present, and no gland orifices are visible on the base of the tongue.

Order INSECTIVORA.

The tongue, like other anatomical characters, is very simple in the Insectivora, and it is possible to show how the tongues of animals belonging to other Orders can be derived from them by specialisation of certain structures or areas. In the present paper the structural characters alone are dealt with, the phylogenetic considerations being postponed till all the systematic papers of this series have been completed.

The tongue is long and narrow in all species, and its free part is of considerable length. It usually thickens gradually from before backwards; but its thickness is not greater in proportion to its length in *Erinaceus* (text-fig. 55). The oral part of the dorsum is long, and the pharyngeal part is short in all species. The apex is rounded, truncated or pointed, and is usually devoid of a notch. The lateral borders are rounded, but they only possess lateral organs in *Erinaceus*.

Median dorsal sulci are absent, but transverse ridges and sulci may be produced by the impression of the palatal rugæ on the tongue. Median ventral sulci are absent, but median ventral crests are present in *Talpa* (text-fig. 56) and *Rhynchocyon* (text-fig. 57); they are blunt in the former, and sharp in the latter.

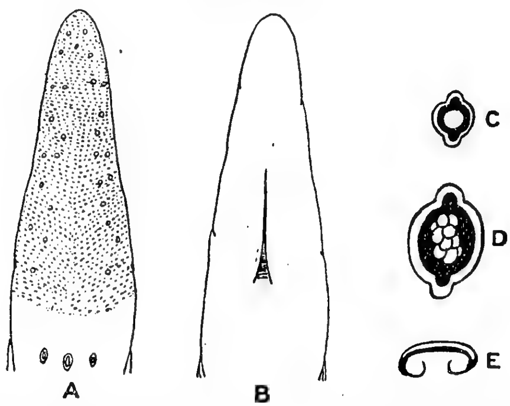
Circumvallate Papillæ:—In the Insectivora there are two large papillæ, or three papillæ in a triangle with the apex turned backwards. And the following list contains the observations of myself and others:—

Family Erinaceidæ:—Two papillæ in *Gymnura rafflesii*.
Three papillæ in all species of *Erinaceus*.
Family Centetidæ:—Three papillæ in *Centetes*, *Ericulus* and *Microgale*.
Family Solenodontidæ:—Three papillæ in *Solenodon paradoxurus*.

Family Potamogalidæ :—Three papillæ in *Potamogale velox*.
Family Chrysochloridæ :—Three papillæ in all species of *Chrysochloris*.
Family Talpidæ :—Two papillæ in all species of *Talpa*, *Myogale*, *Condylura*, *Scapanus* and *Scalops*.
Family Soricidæ :—Two papillæ in all species of *Sorex*.
Three papillæ in *Rhynchocyon*.

The papillæ are round or oval on plan, and cylindrical or conical on elevation. The surface is smooth or granular, and there may be a small central depression. The fossa and vallum are well-marked. Carlier (3) showed that the papillæ in *Erinaceus europæus* contain serous glands and ganglion cells, and their connective-tissue cores are very cellular. The ducts of these serous glands open along with those of the serous glands within

Text-figure 55.



The tongue of *Erinaceus europæus*. A: dorsum; B: under surface; C–E: vallate papillæ.

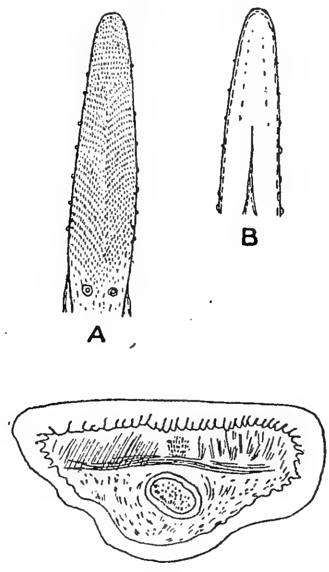
the base of the tongue. The only other Mammals, so far as I am aware, in which there are glands within the vallate papillæ are the Chiroptera.

Fungiform Papillæ :—These papillæ are never very numerous, but more are present in *Erinaceus* and *Chrysochloris* (text-fig. 55) than in any other genus. It may be difficult to detect them, for they are usually very small. Dobson (7) points out, however, that they are prominent in *Gymnura rafflesii* and *Chrysochloris villosa*. They may be composed entirely of epithelial cells, as in *Erinaceus*, or they consist of both epithelial and connective-tissue elements.

Conical Papillæ :—In all species the conical papillæ are numerous and closely packed. They are usually very small on the oral part of the dorsum; and they are usually small on the base as well. The basal papillæ are large in *Centetes* and *Chrysochloris*.

When examined through a hand lens they are seen to be simple in character, having one, two or three points. In *Chysochloris* scoop-shaped forms are present. In many species they are composed entirely of epithelium, which is strongly cornified, the component cells being formed of the strata from the surface down to the Malpighian layer. The different forms are met with in genera of the same family; thus *Gymnura* has bifid papillæ, but *Erinaceus* has them divided into three points. So it is evident that the forms are simpler than in animals belonging to all the Orders hitherto considered in this series of papers.

Text-figure 56.



The tongue of *Talpa europæa*. A: dorsum; B: under surface; C: cross-section showing the oval lytta.

Lateral Organs:—Many authors have described the lateral organs in *Erinaceus*, and some have stated that these structures are absent in all other genera. With both these remarks I am thoroughly in accord.

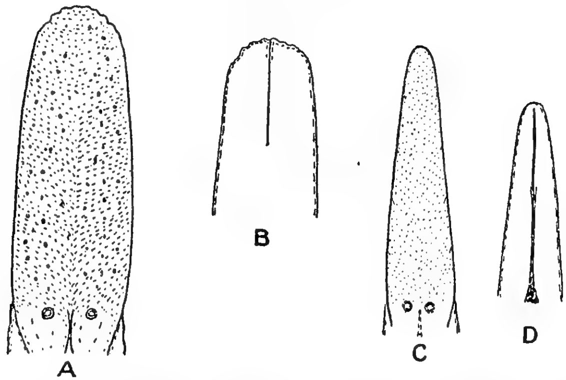
In *Erinaceus europæus*, according to Mayer (**14**) and Gmelin (**9**), the organ consists of two large folds well provided with taste-buds and fat. In the animal examined by myself (text-fig. 55) the organ varied on both sides. On the right side a fissure, with slightly curved ends, much as in *Hydrochærus capybara*; on the left side the fissure undercut part of the dorsum, thereby producing an overhanging lobe.

Glands:—I agree with Carlier (**3**), Oppel (**17**) and Podwisotzky (**19**) that the serous glands are very highly developed, and the mucous glands are scanty in *Erinaceus*. As was mentioned above, serous glands are present even within the vallate papillæ in *E. europæus*. No apical gland of Nuhn exists in any Insectivore.

The *frenum linguæ* is short in all Insectivora except *Tupaia*. And it is fine in *Erinaceus*, but thick in *Talpa*, *Rhynchocyon*, etc. In no case is there any trace of frenal lamellæ as in the Lemuroid Primates.

Sublingua:—It has been shown by Owen (**18**) and Garrod that there is a sublingua in *Tupaia*; Owen described it as a fimbriate plica, but Garrod described it as resembling that in *Chiromys*. Vogt and Yung (**24**) recorded the presence of a sublingua in

Text-figure 57.



The tongues of *Chrysochloris trevelyani* (A and B) and *Rhynchocyon* (C and D). In both cases a third papilla is concealed in the linear groove on the back of the dorsum.

some Insectivora. I found no trace of the sublingua in *Erinaceus*, *Centetes* and *Chrysochloris*, but it may be represented by the median ventral ridge in *Talpa* and *Rhynchocyon*. That ridge may correspond to the median crest which is found on the ventral surface of the sublingua in the Marsupialia and Primates. In that case the remainder of this organ has been absorbed into the tongue.

Lytta:—It has been shown by Nussbaum (**28**), Oppel (**17**), Hesse (**11**), and Ludwig Ferdinand, Prince of Bavaria (**13**), that the lytta is well-developed in *Erinaceus europæus*, *Sorex fodiens* and *Talpa europæa*. It is composed of muscle fibres, fat and fibrillar connective tissue, but no cartilaginous elements are present. The histological details are given fully in the papers enumerated above. I observed a very pronounced lytta in

Rhynchocyon. The lytta in the Insectivora is in many ways similar to that in the Lemuroid Primates.

Musculature:—This has been fully described by Carlier (**3**) and Oppel (**17**).

Conclusions.

1. The tongues of the Edentata and Insectivora are of particular interest, for they afford clear illustrations of some of the principles which should guide us in settling the blood-relationships of animals. Thus they exhibit primitive, convergent and adaptive characters.

2. The tongues of all the American Edentata can be derived from Armadillo-like forms.

3. The tongues of the Myrmecophagidæ are similar in many ways to that of *Manis*, but the resemblances have been produced by convergence.

4. All American Edentata have two circumvallate papillæ, but the African forms have three in a triangle.

5. The differences between the tongues of *Manis* and *Orycteropus* are the result of adaptive modifications.

6. It is a well-established principle of phylogeny that observations should be drawn from all parts of the body; and conclusions as to affinities should not be based on the examination of a single organ. The truth of this can be seen in a study of the Edentata; for an examination of the tongue alone would make one agree that *Manis* and the Myrmecophagidæ are closely related; an examination of the entire anatomy of these animals shows that that is not true.

7. The tongues of the Edentata are more mobile than those of all other Mammals except *Acanthoglossus* and *Zaglossus*.

8. The tongue of *Galeopithecus* has affinities with those of the Insectivora. The characters of its apex, however, are unique.

9. The tongues of the Insectivora are very primitive, for their mechanical papillæ are simple, their gustatory papillæ are not numerous and they have traces or complete examples of the lytta and sublingua. Many of their characters are similar to those of the Lemuroid Primates.

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29. The External Characters of the Pigmy Hippopotamus (*Chœropsis liberiensis*) and of the Suidæ and Camelidæ.

By R. I. Pocock, F.R.S., F.Z.S.

[Received May 28, 1923: Read June 12, 1923.]

(Text-figures 30 to 46.)

Contents.

The fresh material upon which the observations contained in this paper are based was examined in the Society's Prosectorium immediately after the death of the specimens. In the case of some of the Suidæ, like *Porcula* and *Hylochœrus*, I have been compelled to rely upon dried skins in the British Museum.

The only rare species examined was the Pigmy Hippopotamus, of which a single old male example, presented by the Duke of Bedford on December 16, 1913, died February 11, 1919.

Section SUINA.

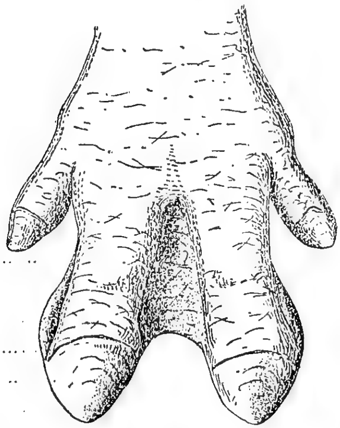
Family Hippopotamidæ.

Chœropsis liberiensis.

Owing to its smaller head, much shorter body, and relatively longer legs, the Pigmy Hippopotamus differs markedly in external appearance from its larger ally. It was generically separated from the latter, owing to the loss of a pair of incisor teeth in the lower jaw.

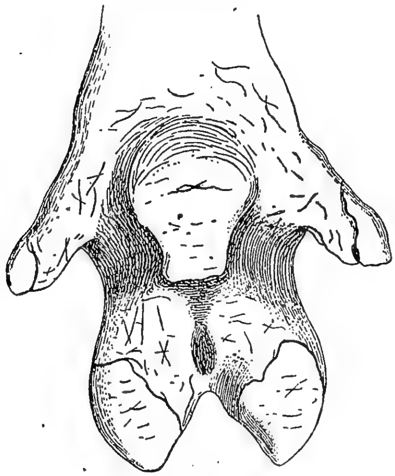
The *muzzle* is provided with short scattered bristles, but, apart

Text-figure 30.



Hind foot of *Chœropsis liberiensis* from above.

Text-figure 31.

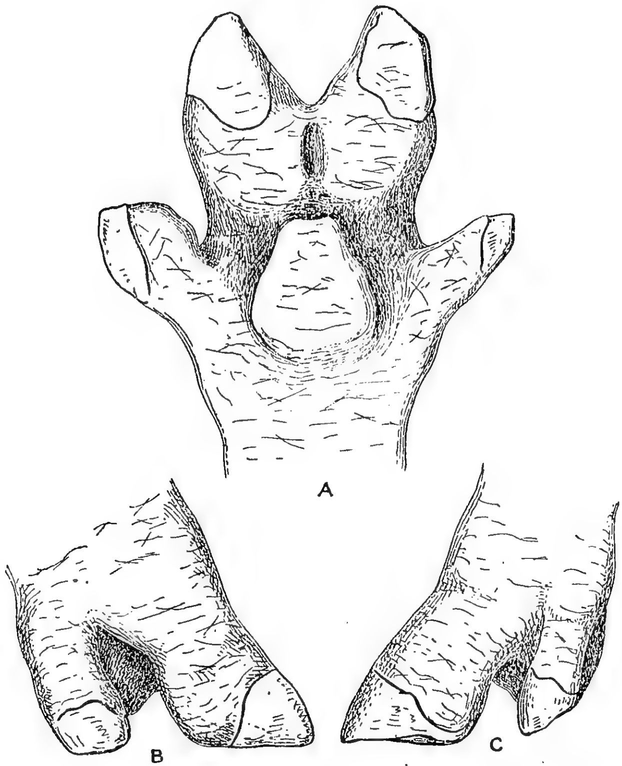


The same from below.

from these, the facial vibrissæ characteristic of the normal terrestrial mammalia appear to be unrepresented. The nostrils are widely separated, oblique, valvular slits, capable of being tightly closed, and look forwards and upwards from the summit of the muzzle. There is no differentiated rhinarium.

The *ears* are small, simple, and, like the nostrils, capable of being tightly closed. The hollow of the outer side is furnished with three soft, ridge-like thickenings which, when the ear is folded, are pressed together so as to block the orifice. (Text-fig. 33, A.)

Text-figure 32.



A. Right fore foot of *Chœropsis liberiensis* from below.
B & C. The same foot from the outer and inner sides.

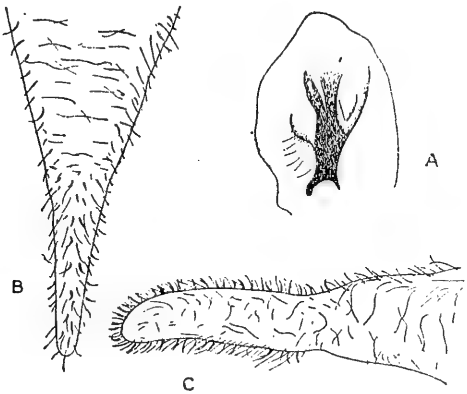
The *feet* are of the most primitive type found in the Artiodactyla. They are symmetrical or nearly so; the tips of the four toes rest on the ground, and with the help of a well-developed plantar pad support the weight of the animal when walking or standing.

The two main digits, morphologically the third and fourth, are united for the greater part of their length by integument, but they are not tightly and compactly welded together. The depression between them on the upper side is tolerably deep; they can be separated to a considerable extent, and their distal ends carrying the hoofs are free. The hoofs are small and bluntly pointed, and there is no clear line of demarcation laterally between their edges and the area of flat horny integument constituting the sole of the toe.

The lateral digits are much smaller, are free from webbing, and the small hoofs encircle their tips.

The sole of the foot is covered with naked wrinkled skin. On the area between the plantar pad and the edge of the webbing uniting the two larger digits there is a shallow depression which may be glandular, but I was unable to investigate its nature by sections. The plantar pad is irregularly heart-shaped, being narrow and more or less truncated in front, where it stands up as

Text-figure 33.



A. Ear of *Chœropsis liberiensis*.
B & C. Dorsal and lateral views of the tail of the same.

a well-defined horny cushion, and widely rounded behind, where it is ill-defined and gradually blends with the integument above or behind it. (Text-figs. 30–32.)

There is no marked difference in size or structure between the fore and hind foot, except that in the latter the two smaller digits are alike in size, whereas in the former the outer digit is considerably thicker and larger than the inner. This is the only particular in which there is distinct asymmetry in the feet.

The feet of living examples of *Hippopotamus amphibius* that I have seen differ from those of *Chœropsis liberiensis* in being much more compactly built. There is no great difference in size between the four digits, and since they are much more closely united by integument, the feet are incapable of the expansion observable in *Chœropsis*. In the greater freedom of the digits the latter genus stands nearer to the Suidæ *.

The *tail* is short. Its base is broad with convex edges, but its distal half is thin, parallel-sided, strongly compressed, and provided with stiff short bristles. It serves apparently merely as a cover to the anus, and in the female of the genital orifice as well. (Text-fig. 33, B, C.)

The *penis* is quite simple, cylindrical for the greater part of its length, and somewhat abruptly attenuated at the apex, the orifice being terminal. The penis is like that of *Sus scrofa*, but has no spiral twist when retracted.

Family Suidæ.

The Rhinarium.

The general character of the rhinarium in the Suidæ is well known. It is a movable disk, the upper and lateral edges of which project to a greater or less extent beyond the skin of the muzzle. Its anterior moist surface is nearly flat, its upper portion being nearly naked, and the lower covered with short, stiff, sparse hairs. The area below the nostrils is usually wider than the area above them, and the edges are, generally speaking, convex, although the lower is less curved than the upper. The nostrils look straight forwards, and are set on each side of the middle line of the disk some distance apart. They do not extend to its lateral edge, the lateral narial slit being absent or so short as to be practically negligible. Their inner and upper edges are sharply defined, but the outer blends gradually with the adjacent surface of the rhinarium.

In most of the genera of the family—*Sus*, *Potamochœrus*, and *Dicotyles*† (*Tayassu* and *Pecari*)—the variation in shape and structure is comparatively slight, and the differences shown in the sketches may be individual and not specific or generic. In all these cases the median height is less than the greatest width by about one-fourth or less, and the sides from the widest points a little below the nostrils are inclined inwards and upwards in a nearly straight line to the curved summit, and the distance between the nostrils is more than one-third but less than one-half the median height.

In an example of *Sus scrofa* the widest part is just below the inferior edge of the nostrils, and the infero-lateral margin is rather markedly convex, and the sides from the level of the

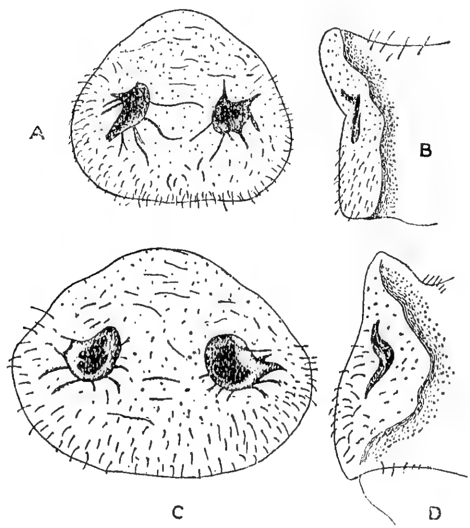
* In the mounted specimen of *Hippopotamus amphibius* in the Natural History Museum, the characters of the feet here mentioned are not so apparent. The approximate equality between the four digits is seen, but there is a deep depression between the second and third, making the feet look more like those of *Chœropsis*. This, however, is probably due to the shrinkage of the interdigital tissue with drying.

† For convenience I retain in this paper the old familiar name *Dicotyles* for the American Suidæ.

nostrils slope upwards and inwards with a slightly sinuous curve to the narrowed, rounded summit. In *S. leucomystax* the greatest width is about midway between the nostrils and the lower edge, which is straighter than in *S. scrofa*, and the height, as compared with the width, is considerably greater than in the latter. (Text-fig. 34.)

In *Potamochœrus porcus* the upper edge is much more widely rounded than in the two species of *Sus*, and the infero-lateral margins at the widest part of the rhinarium below the level of the nostrils is not so widely rounded, the edge from that point inclining inwards and upwards, being very lightly concave. (Text-fig. 35, B.)

Text-figure 34.



A, B. Front and side views of rhinarium of *Sus leucomystax*.
C, D. The same of *Sus scrofa*.

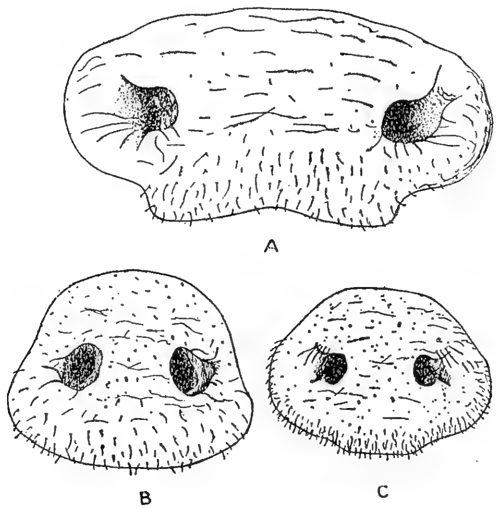
In two species of Peccary, the collared (*D. tajacu=torquatus*) and white-lipped (*D. pecari=labiatus*), the rhinarium is as wide on a level with the upper edge of the nostril as below that point, which is not the case in *Sus* or *Potamochœrus*. (Text-fig. 35, C.)

In *Phacochœrus* the rhinarium differs from that of the genera described above in several particulars. It is about twice as wide as high, has a lightly convex upper edge, the lateral margins strongly convex round the nostrils, and sinuously concave below where they form a definite angle with the lower edge, which is lightly concave, especially in the middle line. (Text fig. 35 A.)

It is not possible to determine the exact shape of the rhinaria on dried skins; but so far as I can judge from material in the Natural History Museum, the rhinarium of *Hylochœrus* is relatively much larger than in *Potamochœrus*, and approaches in relative width that of *Phacochœrus*.

Porcula, as might be expected, appears to resemble *Sus* in the shape of this organ.

Text-figure 35.



A. Front view of rhinarium of *Phacochœrus africanus*.
B. The same of *Potamochœrus porcus*.
C. The same of *Dicotyles pecari*.

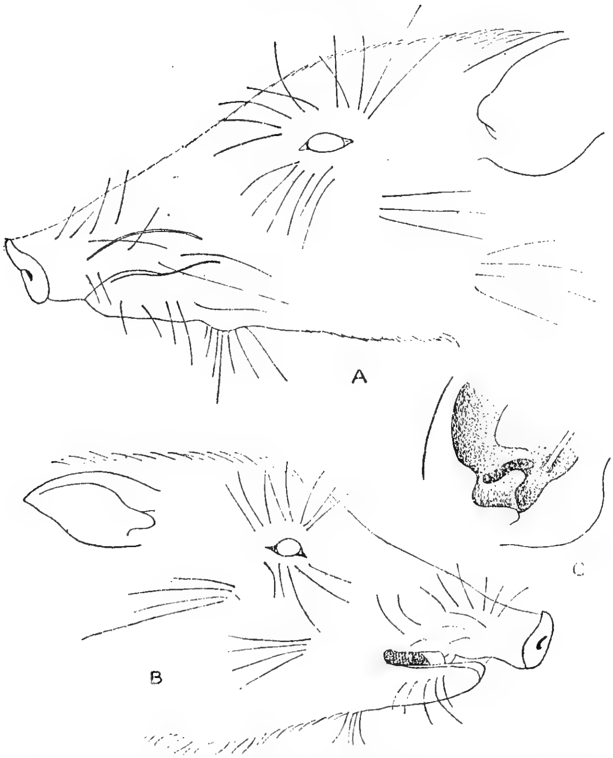
The following table of measurements in mm. will show the principal distinctive features of the rhinarium of *Phacochœrus* as compared with that of the other genera:—

	Height.	Width.	Distance between nostrils.
Sus scrofa	64	88	23
Sus leucomystax	55	63	18
Potamochœrus porcus	51	63	19
Dicotyles pecari (*labiatus*)	43	57	18
Phacochœrus africanus	52	112	53

The Facial Vibrissæ.

The full complement of facial vibrissæ characteristic of the Mammalia can sometimes be detected in the Suidæ, but I have failed frequently to trace the genal tufts, owing to their being either suppressed or indistinguishable in the thick clothing of coarse hair which generally covers the cheek. The mystacials

Text-figure 36.



A. Side view of head of *Potamochœrus porcus* showing facial vibrissæ.
B. The same of *Dicotyles pecari*.
C. Base of the ear of *P. porcus*.

are relatively short and scattered, and apparently of less importance than the others, probably on account of the prominence and sensitiveness of the specialized rhinarium. The lower lip is always provided with scattered submentals approximately as long as the mystacials; but the superciliaries and suboculars are always long and plentiful as if the protection of the eye was of importance. Typically the interramal tuft is composed of about half a dozen moderately long vibrissæ.

In the two species of Peccary (*D. tajacu* and *pecari*) I have found all the tufts developed as described above, and, in addition, the two genal tufts, the lower situated in a line with the slit of the mouth and beneath the anterior angle of the eye, the upper higher up and beneath and behind the posterior angle of the eye. (Text-fig. 36, B.)

In *Potamochœrus porcus* the ocular and interramal vibrissæ are well developed, and I detected two genal tufts, the upper situated as in *Dicotyles*, the lower set very far back beneath the base of the ear on the angle of the lower jaw. The upper tuft, however, was only distinguishable from the normal coarse hairs of the cheek by rising from a low integumental swelling, and the homology of the lower tuft with that of *Dicotyles* is rendered a little doubtful by its abnormally backward position. (Text-fig. 36, A.)

In dried skins of *Porcula salvania* the buccal, ocular, and interramal vibrissæ are normally developed, but the genals are indistinguishable.

In *Phacochœrus* the buccal and ocular vibrissæ alone seem to be constant. In one case I detected a few bristles set about one inch below the subocular wart, which I believe to represent the upper genal tuft; but I could find no trace of the lower genal tuft, unless a short row of black bristles beneath the white fringe on the cheek is to be referred to it. The interramal is represented at most by one or two long bristles.

In dried skins of *Hylochœrus* the buccal and ocular vibrissæ are as in *Phacochœrus*, but the genals are not traceable in the long hairs of the cheek. I may here add that the fringe of pale hair on the cheek in *Hylochœrus* seems to overlie an area of skin with special glandular activity.

The Ear.

Boas (Die Ohrknorpel . . . der Säugethiere, 1912) describes and figures the ears of *Sus scrofa* and *Dicotyles tajacu*. Each is provided with three supporting ridges, the anterior of which is curved backwards at the base, where it arches over a deep groove bounded below by an oblique thickening or ridge, which is itself defined by a deep groove from the basal thickening which descends to the auditory orifice. The anterior edge of the pinna is turned backwards in both genera, and the posterior edge as well in *Dicotyles*. At the base of the anterior edge there is a small excrescence.

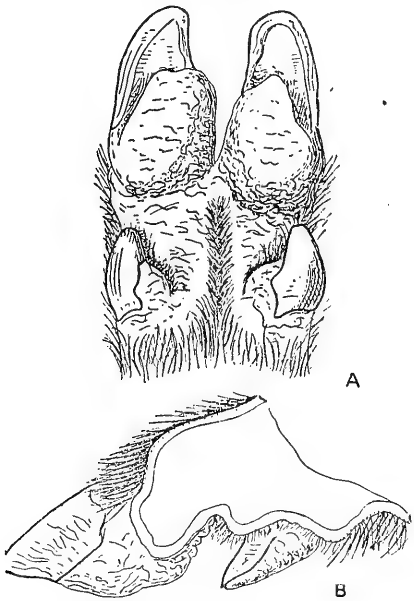
In *Potamochœrus porcus* the anterior edge is folded backwards at the base, but there are no definite tragal or antitragal thickenings. There is a feebly-developed anterior and posterior supporting ridge, and the former rises inferiorly close to the basal thickening, which is divided into an upper and a lower part by a deep groove or cleft. The part above this groove forms an abbreviated longitudinal thickened ridge, well defined in front, but blending behind with the integument of the ear. It suggestively resembles the supratragus (*plica principalis*) of the ear of typical mammals, the retention of which in the Suidæ would be of interest, but Boas does not identify it with that ridge. The part below the groove descends into the tubular part of the ear, and is pierced inferiorly by the auditory orifice. Its upper edge, just beneath the supratragal ridge, is raised posteriorly into a rounded excrescence. (Text-fig. 36, C.)

The ears vary in size and shape according to the genera. In *Sus scrofa* and *Potamochœrus porcus* the posterior edge is lightly concave above and widely rounded below, the apex being more elongated in the latter than in the former genus. In *Phacochœrus* the posterior border is not widely rounded inferiorly, but is emarginate, and above the emargination there is an angular lappet.

The Feet.

The feet of the Suidæ differ from those of the Hippopotamidæ in that progression is bidigital, the weight of the body resting

Text-figure 37.

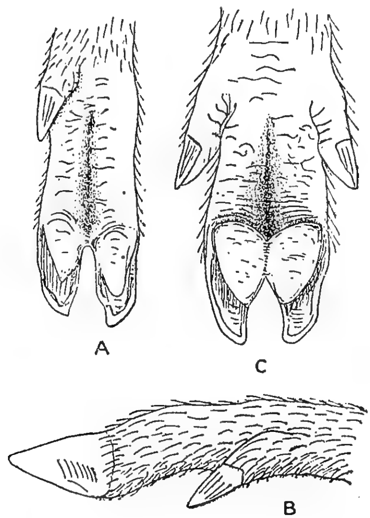


A. Lower view of foot of *Sus scrofa*.
B. Section of foot of the same.

upon the hoofs of the second and third digits, those of the first and fourth at most touching the ground with their tips. There is no median plantar pad, but the third and fourth digits are provided beneath with two horny pads behind the nail of the hoofs, constituting a pair of heels. The nails of these digits are narrowed apically, flattened on the inner side, and fit together like those of typical ruminant Artiodactyles.

Except for the well-known variation in the case of *Dicotyles*, where the fourth or outer digit of the hind foot is absent, the inner being retained and used for scratching, the feet of the different genera and species of Pigs are very much alike. The interdigital depression is shallow, sparsely hairy, and not glandular, and the back of the pasterns and fetlock to a point just above the lateral hoofs is usually naked, although in

Text-figure 38.



A. Lower view of left hind foot of *Dicotyles*.

B. The same from the side.

C. Lower view of foot of *Phacochœrus*, showing the fusion of the heels.

an example of *Sus scrofa* there was a median line of hair extending almost down to the heels. The foot of *Phacochœrus* differs, however, from that of *Dicotyles*, *Sus*, *Porcula*, and *Potamochœrus* in having the heels united; but the degree of fusion is, I think, variable, although in some cases it is very marked and practically complete. Judging from dried skins, *Hylochœrus* has separated heels like *Potamochœrus*. (Text-figs. 37, 38.)

I have found no specialized glands in the feet either of *Dicotyles* or *Phacochœrus*, and with regard to the incidence of the glands that have been recorded in other genera, further information is required before definite conclusions can be reached.

Those on the carpus of the common pig are well known, and are said to occur in both boars and sows. I figured and described them as seen in a wild boar, *Sus scrofa*, but I subsequently failed to find a trace of them in a sow of this species and also in a sow of the Japanese species, *Sus leucomystax*, and I similarly failed in the case of a boar of the Indian species, *Sus cristatus*.

I have had no opportunity of studying further the peculiar glands in the feet of the male of *Potamochœrus porcus*, which I described a few years ago (Proc. Zool. Soc. 1916, p. 747), and can add nothing to the original account.

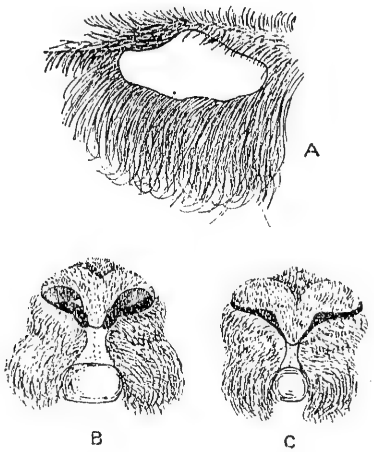
Section TYLOPODA.

Family CAMELIDÆ*.

The Muzzle.

The facial vibrissæ in this family are so poorly developed as to be practically negligible.

Text-figure 39.



A. Metatarsal gland of the Alpaca (*Lama glama*).
B. Muzzle of *Lama huanacus* with the lips spread and the nostrils dilated.
C. The same of *L. vicugna* with the lips only partially spread and the nostrils nearly closed.

The muzzle has the upper lip completely cleft, the two halves being freely movable and separated by a philtrum of naked skin, which extends down to the premaxillary gum-pad against which

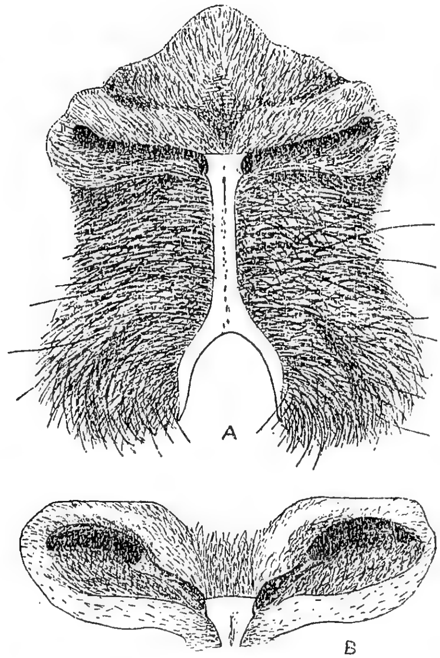
* In all the examples of *Lama* that I have dissected, and in the one example of *Camelus dromedarius*, I found the so-called "water-cells" of the rumen packed with food and not filled with water. They are no doubt primarily "food-cells," and secondarily become filled with water in *Camelus* when food is unobtainable.

the lower incisors bite. The two halves of the upper lip hang down on each side of this pad. The upper surface of the nose and the area all round the nostrils, which are elongated dilatable slits, are covered with fine short hairs.

In *Lama vicugna* and *huanacus** the internarial septum is hairy, and the philtrum is a short area about twice as long as wide when expanded. (Text-fig. 39, B, C.)

The muzzle of *Camelus dromedarius* closely resembles that of

Text-figure 40.



A. Muzzle of *Camelus dromedarius* with nostrils nearly closed.
B. Nostrils of the same dilated.

Lama, but is much deeper below the nostrils and has the philtrum very much longer. Inferiorly, moreover, the philtrum is continued on each side as a narrow strip along the inner edge of the lips, while it is slightly expanded above and abuts against the inner ends of the nostrils. The nostrils are long and valvular,

* In Lydekker's Catalogue of Ungulates, iv. p. 302, the Huanaco is cited as *Lama glama huanacus*, on the assumption that it is the wild form from which the domesticated Llama and Alpaca were derived. The differences between the wild and the tame animals are, however, too well marked to warrant the unqualified acceptance of that opinion. The Llama, indeed, may represent a species wholly reclaimed from the wild state.

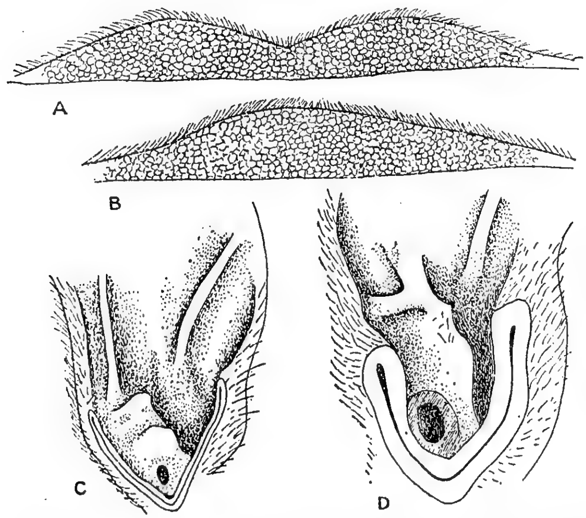
and are lined for some distance inside with short hair. (Text-fig. 40, A, B.)

The complete cleavage of the upper lip by a philtrum, and the mobility of its two halves inferiorly where they project below and on each side of the premaxillary gum-pad, are characters of the Tylopoda as remarkable as any that are usually cited as diagnostic of that section of Artiodactyla.

The Occipital Gland of Camelus.

In my paper on the Specialised cutaneous scent-glands of Ruminants (Proc. Zool. Soc. 1910, p. 973), I described the occipital gland of the two species of *Camelus* as observable on the living animals. I there stated that there are a pair of such glands. That was an error due to the interpretation of the gland by touch. There is a single gland, about as wide as long and

Text-figure 41.



A. Transverse section of the occipital gland of *Camelus dromedarius.*
B. Longitudinal section of the same.
C. Base of ear of *Lama vicugna.*
D. The same of *Camelus dromedarius.*

covered with hair. It is composed of thickened skin, which gradually thins out marginally where it runs into the normal skin at the back of the head. Its lower half is rather thicker than the upper, and in the middle there is a wide and tolerably deep longitudinal depression, and it was the resulting biconvexity of the gland which deceived me into thinking there were two. (Text-fig. 41, A, B.)

The Ears.

The ears of *Lama* are long, narrow, and pointed *. On their inner surface they are strengthened by two longitudinal ridges. The posterior of these is slightly oblique, and does not descend inferiorly into the posterior portion of the ear. The anterior is straighter, and inferiorly rises close to the basal thickening, which forms a rounded prominence. This thickening is pierced below by the auditory orifice. These ears are remarkably like those of the typical Ruminant Artiodactyla. (Text-fig. 41, C.)

The ear of *Camelus dromedarius* is much shorter and wider and less freely movable on the head than that of *Lama*. The two internal ridges are soft, low, and short, and probably little more than functionless vestiges of those present in *Lama*. The basal prominence is tolerably similar to that of *Lama*, but at its upper extremity there is a deep transverse groove cutting off a ridge, the position and structure of which suggest its homology with the supratragus of normal mammals. The posterior extremity of the ridge turns upwards behind the base of the anterior of the two soft ridges above mentioned. (Text-fig. 41, D.)

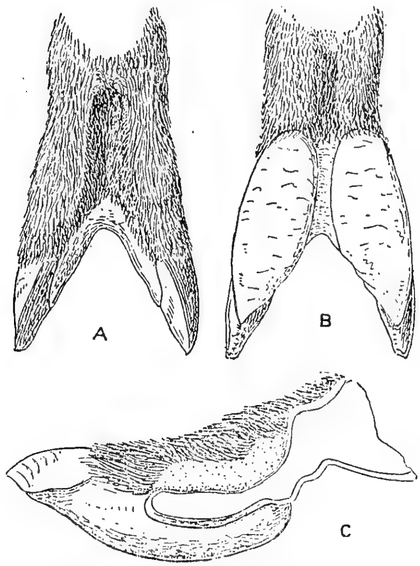
The Feet.

In *Lama* the feet are long and narrow, each of the digits being provided with an elongated cushion-like pad, rounded behind and narrowed in front, where it runs into the small, somewhat nail-like hoof. Distally the digits are capable of being widely separated by a deep cleft between them. Behind this cleft the soles are united, but the extent of their fusion varies to a certain degree. In an example of *L. glama* the fusion was so complete as to obliterate superficially all trace of the line of junction. But in *L. vicugna* there was a tolerably deep, wide, and long groove between them. A similar but shallower and narrower groove separated the heels in an Alpaca; and in this animal the cleft between the digits extended half-way along the soles, whereas in *L. glama* and *L. vicugna* the interdigital cleft was shorter. On the upper side of the foot there is a long, deep, interdigital depression lined with glandular integument, secreting a waxy substance smelling like the urine of *Mus musculus*. In *L. vicugna* and *L. glama* the floor and sides of this depression were naked, but in an Alpaca they were clothed with hair for the most part, only the distal edge of the depression being naked on both fore and hind foot. On the latter the proximal deepest portion, where the skin is most active, was also naked, whereas on the fore foot the corresponding spot was clothed with short radiating hairs. (Text-figs. 42, 43.)

In the Proceedings of this Society for 1916, p. 748, I described and figured the two metatarsal glands of *Lama vicugna*. The

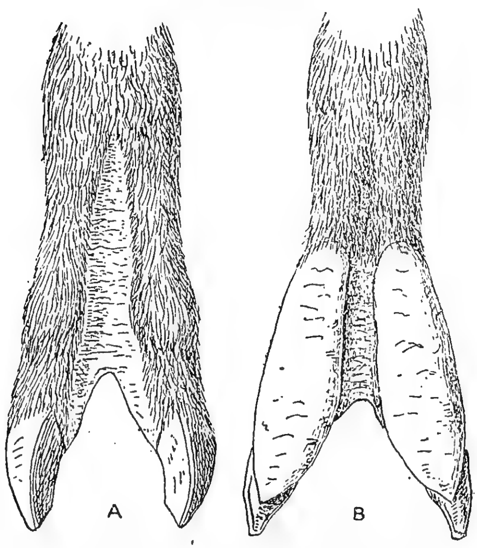
* In the domesticated races, but not in the wild species, the tips of the ears are, typically at all events, curved slightly forwards.

Text-figure 42.



A, B. Upper and lower views of foot of *Lama glama* (Alpaca variety).
C. Section of foot of *Lama glama* (common variety).

Text-figure 43.

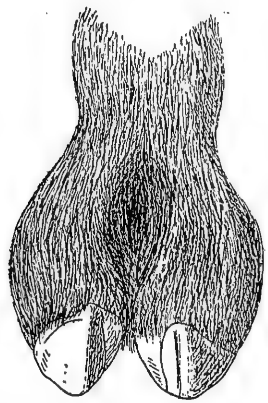


A, B. Upper and lower views of foot of *Lama huanacus*.

naked, depressed glandular area, overlapped by hair, was about four times as long as wide, and gradually narrowed at its distal end. In a male Alpaca the glandular area was more exposed than in the Vicuña, was not depressed but flat, and was only overlapped by hair at the extreme margin above distally. It was also shorter and differently shaped, its length being $1\frac{3}{4}$ inches and its breadth $\frac{3}{4}$ of an inch; the lower border was sinuously convex and the upper had a submedian bulge; its proximal and distal ends were approximately equal in width, the former being $7\frac{1}{4}$ inches from the hock, the latter 5 inches from the fetlock. (Text-fig. 39, A.)

The feet of *Camelus dromedarius* are more specialized than those of *Lama*. The two digits are fused nearly up to the hoofs, so that their under sides form a continuous sole, about as wide as long, with at most a shallow, irregular, median crease to mark

Text-figure 44.



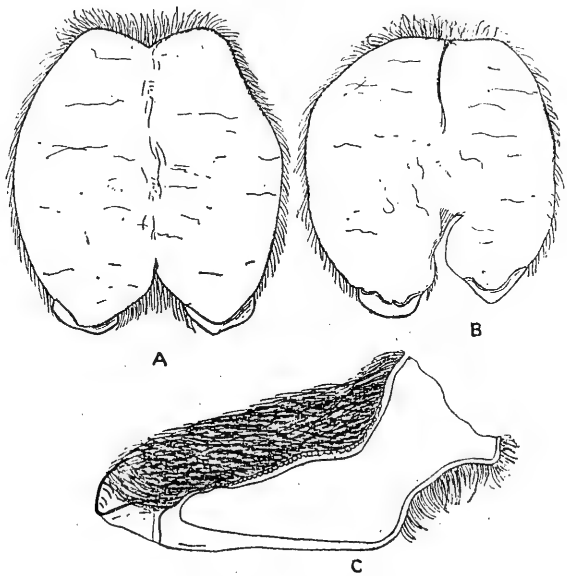
Upper view of foot of *Camelus dromedarius*.

the line of union. At the digital end of the sole there is a tolerably deep angular emargination where the digits are free and diverge from one another. The fore foot is both wider and longer than the hind foot, and in the specimen examined was narrowed posteriorly, the hinder edge of the sole, or heel, showing a shallow angular emargination. In the hind foot, on the contrary, the posterior border of the sole was convexly rounded, and formed a continuous curve with the lateral margins, which, like those of the fore foot, were tolerably evenly but lightly convex. This hind foot was asymmetrical, the inner digit being larger than the outer, and the proximal cleft between them was twisted externally at its deepest part. On the upper side of both fore and hind foot there is a deep, long interdigital depression lined throughout with hair, and glandular, the secretion having a strong odour like the urine of *Mus musculus*. The skin of the sole is not very thick at the heel, but it thickens towards the hoofs, forming a strong junction at this point between the two digits. The inner surface of each digit between this junction and the hoof is naked. (Text-figs. 44, 45.)

The Penis.

Athough the penis in the Camelidæ has been previously described, this organ in the Mammalia generally is so important from the systematic standpoint that I venture to draw attention to the profound differences it exhibits in this family from that of the rest of the Artiodactyla. In the latter the glans is always

Text-figure 45.

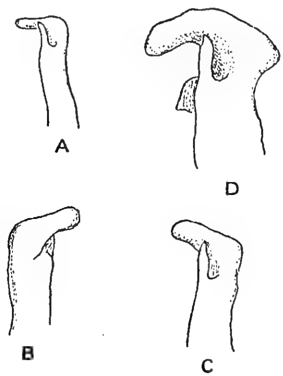


A, B. Lower view of fore and hind foot of *C. dromedarius*.
C. Section of foot of the same.

soft and flexible. Considering its length, it seems remarkable that in no case has an os penis or baculum been developed. In the Camelidæ also there is no baculum, but the tip of the glans instead of being soft is rigid, hard, and apparently cartilaginous. The apex, moreover, is bent sharply to the left, like a stout hook, underlying and apparently acting as a guard to the slender, straight, forwardly directed process, at the tip of which the genito-urinary orifice opens.

In the Alpaca and in *Lama huanacus* the hook is simple and nearly straight. In the latter it is slender, and is bent at right angles to the axis of the glans; whereas in the Alpaca it is stouter, and is bent at an obtuse angle. In *Camelus dromedarius* the hook forms an almost rectangular bend, but is slightly curved and has a lightly convex anterior and a concave posterior edge.

Text-figure 46.



A. Tip of glans penis of *Lama huanacus* from above.
B, C. Lower and upper views of the same of *L. glama* (Alpaca).
D. The same of *Camelus dromedarius* from above.

Externally on the right side it forms a shoulder-like excrescence, defined posteriorly by a deep concavity from the main part of the glans; and on the left side there is a soft projecting lappet on the glans behind and beneath the base of the little process carrying the genito-urinary orifice. (Text-fig. 46.)

30. A Revision of the Family PANTOPHTHALMIDÆ [Diptera], with Descriptions of New Species and a new Genus.

By Major E. E. AUSTEN, D.S.O., F.Z.S.

[Received May 29, 1923: Read June 12, 1923.]

(Text-figures 1–11.)

TABLE OF CONTENTS.

(a) *Introduction and Acknowledgments.*

In spite of, as compared with the vast majority of Diptera, imposing size and striking coloration—characters likely to attract the attention of collectors in countries in which the flies forming the subject of this paper are found—Pantophthalmidæ (formerly known as Acanthomeridæ) are singularly rare in collections. It is difficult to suggest even a possible reason for this, unless it is to be found in the habits of the adult insects, which probably spend most of their time in the depths of Neotropical forests.

At the present moment the series of these great Diptera in the British Museum (Natural History), though doubtless the most extensive in any collection in Europe, consists of only sixty specimens. These, however, include no fewer than twenty-four examples from the collection of the late M. J. M. F. Bigot, which Mr. J. E. Collin, F.E.S., has most generously presented to the National Collection during the preparation of this paper. The fact that among M. Bigot's series of specimens are the types of five species, described by himself, Macquart or Bellardi, renders this addition peculiarly valuable, and its timely acquisition has enabled the writer in the course of subsequent pages to elucidate for the first time a considerable amount of synonymy. It is therefore a pleasant task hereby to express to Mr. Collin, on behalf of the Museum, sincere thanks for his public-spirited and most welcome gift.

Acknowledgments are also due to Professor E. B. Poulton, F.R.S., F.Z.S., for the kind loan of the Pantophthalmid material,

amounting to twenty specimens, in the Hope Department of the Oxford University Museum; and to Dr. Hugh Scott, F.E.S., for similarly allowing the author to examine a female of *Pantophthalmus chuni* Enderl. and a larva (represented in text-fig. 1, on p. 557) of *P. tabaninus* Thunb., both of which are the property of the University Museum of Zoology, Cambridge.

It only remains to add that, unless otherwise stated, all specimens mentioned in the following pages, including the types of new species, are in the British Museum (Natural History).

(b) *Bibliography.*

Apart from descriptions of genera and species already published, references to which will be found in the "Systematic Portion" (h) of this paper, the more important items comprised in the scanty literature of Pantophthalmidæ are the following:—

BRAUER, FR.—Description of a dried larva of *Pantophthalmus* (*Acanthomera*) *frauenfeldi* Schin. Denkschr. K. Akad. Wiss., Math.-Naturw. Cl., Bd. xlvii. p. 25, Taf. ii. figs. 25 *a*–25 *e* (Wien, 1883).

OSTEN SACKEN, Baron C. R.—"Fam. Acanthomeridæ." Biol. Centr.-Amer., Diptera, vol. i. pp. 63–68 (1886).

FIEBRIG, K.—"Eine morphologisch und biologisch interessante Dipterenlarve aus Paraguay (*Acanthomera teretruncum* sp. n. Fiebrig)." Zeitschr. f. wiss. Insektenbiologie, Bd. ii. pp. 316–323, 344–347, figs. 1–19 (1906).

WILLISTON, S. W.—"Family Acanthomeridæ." Manual of N. Amer. Diptera, 3rd Ed., pp. 173–175, figs. 2, 61, 62 (London: Wm. Wesley & Son, 28 Essex Street, Strand, 1908).

ENDERLEIN, G.—"Die Dipteren-Familie Pantophthalmidæ." Zool. Anzeiger, Bd. xli. pp. 97–118, figs. 1–15 (1912).

ENDERLEIN, G.—"Weitere Beiträge zur Kenntnis der Pantophthalmiden." Zool. Anzeiger, Bd. xliv. no. 13, pp. 577–586 (July 28, 1914).

HERMANN, F.—"Ein neuer *Pantophthalmus* nebst kritischen Bemerkungen über die Systematik der Pantophthalmiden (Dipt.)." Deutsche Ent. Zeitschrift, Jahrg. 1916, pp. 43–49, Abt. 1, 2 (1916).

(c) *Geographical Distribution.*

Pantophthalmidæ are confined to the Neotropical Region, where, however, their range is wide, extending from Mexico to Paraguay, and including at least a portion of the West Indies. It is true that, as pointed out by Osten Sacken (*loc. cit.* p. 66), Thunberg's statement (*cf. infra*, p. 562) as to the provenance of the type of *Pantophthalmus tabaninus*—the first species of this family to be described—"still requires confirmation." Nevertheless, considering that some eleven years ago the same species (subsequently regarded by Knab as new, and described by him under the name *Pantophthalmus fastuosus*) was found by Mr. F. W. Urich breeding in Trinidad; that, as is well known, the Dipterous fauna of the West Indies generally is "essentially a common one, with a strong South American facies" *; and that the islands of the Lesser Antilles are only separated one from another by short intervals of sea—there can be no real reason to doubt the accuracy of Thunberg's century-old assertion that the type of this species came from St. Barthélemy I.

(d) *Taxonomic Position.*

Williston ('North American Diptera,' 3rd Ed., p. 175, 1908), who places the "Family Acanthomeridæ" between Stratiomyiidæ and Tabanidæ, writes:—"The relationships of the family are very close indeed to the Stratiomyidæ, and the families might, very properly, be united." Kertész, however, in vol. iii. of his 'Catalogus Dipterorum,' published in the same year, gives the families embraced by the volume in the following sequence: Stratiomyiidæ; Erinnidæ (Xylophagidæ); Cœnomyiidæ; Tabanidæ; Pantophthalmidæ; Rhagionidæ (Leptidæ *olim*). Enderlein, on the other hand (Zool. Anz., Bd. xli. p. 97, 1912), considers that, from a phylogenetic standpoint, the Pantophthalmidæ are extraordinarily closely allied to the Xylophagidæ and Cœnomyiidæ, and that the morphological relations between all three are so pronounced that they might be regarded as groups belonging to a single family, namely the Xylophagidæ. The latter would then be divided into the subfamilies Xylophaginæ, Cœnomyiinæ, and Pantophthalminæ. Remarking that the presence or absence of spines on the scutellum, the relative size of the head and differences in bodily shape, whether slender or thickset, furnish insufficient grounds for the separation of families, Enderlein proceeds to show with the help of a diagram that in venation also the differences between Pantophthalmidæ, Xylophagidæ, and Cœnomyiidæ are unimportant. Hermann, in his paper published four years later, while criticising Enderlein somewhat severely in connection with other details, nevertheless (Deutsche Ent. Zeitschr., Jahrg. 1916, p. 47, 1916) expresses his complete agreement with him (and disagreement with Kertész) in respect of the closeness of the relationship between the Pantophthalmidæ, regarded as a family, and the Xylophagidæ and Cœnomyiidæ.

There can be no doubt that the views of Enderlein and Hermann as to the systematic position of the Pantophthalmidæ are correct, and indeed, in order to be satisfied upon this point, it is only necessary to compare two representative species, such as *Pantophthalmus pictus* Wied. and *Xylophagus ruficeps* Lw.

In view of the life-history of Pantophthalmidæ (*vide infra* (f)),

* Williston, Trans. Ent. Soc. Lond. 1896, p. 445 (1896).

it is perhaps worth while to recall that the preliminary stages of Xylophagidæ and Cœnomyiidæ are also associated with trees, albeit in a dead or mouldering condition, the larvæ, which in the case of the two latter families are carnivorous and predaceous, living in decaying wood and under bark.

(e) *Bodily Dimensions in* Pantophthalmidæ *compared with those of Exceptionally Large Diptera belonging to other Families.—Giantism.*

Although, as will be seen directly, in wing-expanse, and of course in length of leg, Pantophthalmidæ are surpassed by certain Tipulidæ of abnormal size, while length and wing-expanse in the largest species are about the same as or somewhat below the corresponding dimensions of the largest representatives of the Mydaidæ, the members of the present family as a whole are undoubtedly by far the *bulkiest*, and therefore the largest of all Diptera.

Among slenderly built Diptera, the largest forms are to be found in the Tipulidæ, wherein, as regards actual size, certain species of the genus *Ctenacroscelis* Enderlein are probably without existing rivals. Thus, a male belonging to a variety of *Ctenacroscelis brobdignagius* Westw., from China (N.-W. Sze Chuen), just over 39 mm. ($1\frac{1}{2}$ inch) in length, has a wing-expanse of 104 mm. (rather more than 4 inches), while the outstretched legs cover an area at least $6\frac{3}{4}$ inches in length by 5 inches in breadth.

Although the family Mydaidæ includes a number of species, the representatives of which are of moderate dimensions, certain members of the genus *Mydas*, which are among the largest of Diptera, are relatively gigantic. By way of illustration, mention may be made of *Mydas prægrandis* Austen, a male of which from Brazil has a wing-expanse of 85 mm. (between $3\frac{1}{4}$ and $3\frac{1}{2}$ inches), while the length of this insect, exclusive of the long and prominent antennæ, is 48 mm. (between $1\frac{3}{4}$ and 2 inches)*. The dimensions of this species, in fact, as represented at any rate by the type and paratype (both males) in the National Collection, are but slightly larger than those of the somewhat aberrant representative of the Pantophthalmidæ originally described by the

* Writing with reference to what is almost certainly the female of this species, of which he gives a life-size illustration derived from a photograph, Williston (N. American Diptera, pp. 16, 17, fig. 1, 1908) furnishes considerably higher measurements, remarking :—"The largest specimen of a fly of which I have knowledge is that figured herewith natural size, pertaining to an indeterminable species of *Mydas* from South America. The length of this specimen from the tip of the antennæ to the extremity of the abdomen, is sixty-seven millimeters, or, omitting the antennæ, fifty-two millimeters; the expanse of wings one hundred and seventeen millimeters, or a little more than four and one-half inches. The smallest dipteron that I have ever observed in the examination of many thousand specimens and five or six thousand species, is a cecidomyid measuring a trifle less than one-half millimeter, also omitting the antennæ. In other words, the *Mydas* is more than one million times the size of the cecidomyid. Possibly there are still greater discrepancies between the largest and smallest specimens of the order, but in all probability not much."

author as *Rhaphiorhynchus rothschildi*, for which a new genus is erected in the present paper (*cf.* p. 596).

Turning to the Asilidæ, we find in this enormous family a wide range in size, and a considerable number of species which, though smaller than the larger examples of the genus *Mydas* such as that just mentioned, are yet of exceptional dimensions, some of the largest forms being met with, for example, in the genera *Proagonistes*, *Alcimus*, *Phellus*, *Blepharotes*, *Hyperechia*, and *Proctacanthus*. A male belonging to an undescribed species of *Proagonistes* from Madagascar, 41 mm. (between $1\frac{1}{2}$ and $1\frac{3}{4}$ inch) in length, has a wing-expanse of 80 mm. (between 3 and $3\frac{1}{4}$ inches); while, owing to the extraordinary length of the hind legs, the space from the tips of these, when outstretched, to those of the similarly extended front legs measures at least 82·5 mm. ($3\frac{1}{4}$ inches). The slender-bodied *Alcimus brevipennis* Ric., from Natal, has in the female sex a length of 44 mm. (just under $1\frac{3}{4}$ inch), though its wing-expanse amounts only to 55 mm. (between 2 and $2\frac{1}{4}$ inches). Among the much more stoutly built representatives of the Australian genus *Phellus*, a female from South Queensland, belonging to a species as yet undescribed, measures 50 mm. (just under 2 inches) in length inclusive of the ovipositor, and has a wing-expanse of 81 mm. (a little under $3\frac{1}{4}$ inches). The female of *Blepharotes coriarius* Wied., from the same region, may measure 42 mm. (between $1\frac{1}{2}$ and $1\frac{3}{4}$ inch) in length, and have a wing-expanse of 76 mm. (3 inches). Several of the species of *Hyperechia* are bulky-bodied flies of large size, one of the largest being *H.* (*Laphria*) *consimilis* Wood (syn. *Dasyllis usambaræ* Lichtwardt), of which the type (a female from Natal) is 33 mm. (over $1\frac{1}{4}$ inch) long, and has a wing-expanse of 62·5 mm. (very nearly $2\frac{1}{2}$ inches). Among narrow-bodied Asilidæ (subfamily Asilinæ), an exceptionally large species is *Proctacanthus* (*Asilus*) *penultimus* Walk., the type of which—a male from India—is 40 mm. (over $1\frac{1}{2}$ inch) long, and has a wing-expanse of 60 mm. (between $2\frac{1}{4}$ and $2\frac{1}{2}$ inches).

Lastly, as regards Pantophthalmidæ other than the species already mentioned, the wing-expanse in the case of females belonging to the largest forms such as *Pantophthalmus bellardii* Bell. may amount to 84·5 mm. (a little over $3\frac{1}{4}$ inches), and the length over all (*i.e.* including the ovipositor but not the antennæ) to 54 mm. (over 2 inches); while the broad, flat abdomen may measure 22 mm. (considerably more than $\frac{3}{4}$ inch) in width at its widest point. In the female sex of certain other species, notably *Pantophthalmus tabaninus* Thunb., dimensions are often little below those just given. Species of Pantophthalmidæ however exist, in which, so far as it is at present possible to judge from the limited amount of material available for examination, the same standard of bodily development is not attained; and on the other hand there are indications that, in some cases at any rate (as, *e.g.* in *P. tabaninus*), the average size of the males is considerably less than that of the females.

The fact remains, however, that in the adult state dimensions in Pantophthalmidæ as a whole are greatly in excess of the normal in Diptera, and this small group of large flies consequently forms an interesting case of the phenomenon known as *giantism*, concerning which Williston (*op. cit.* p. 17) writes as follows:—"Giantism in any group of animal life is a specialization, and is, in general, an indication of approaching decadence; enduringly small races are never the descendants of giants, for decrease in size means lessened vitality and incipient extinction. No strong or dominant group of flies, like the Tachinidæ, Dolichopodidæ, Syrphidæ, or Bombyliidæ, has ever had in the past a larger average bodily size than is found among their living representatives. On the other hand, those families composed to-day chiefly of large forms are ones already past their prime. These conclusions seem established for the larger forms of life, and I believe that they are in the main also applicable to insects."

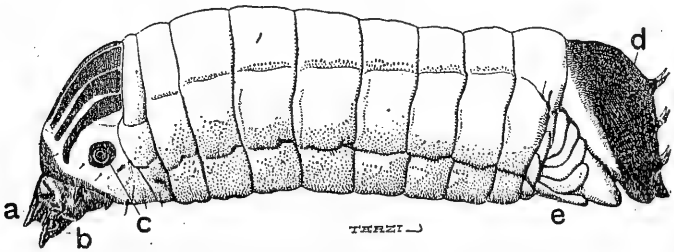
(f) *Life-history and Bionomics.*

Until the year 1906, knowledge under this heading was limited to a brief, illustrated description by Brauer of a dried larva of *Pantophthalmus (Acanthomera) frauenfeldi* Schin. from Bogota (*cf.* "Bibliography," p. 552); and Osten Sacken's statement (Biol. Centr.-Amer., Diptera, vol. i. p. 66), published three years later on the authority of Mr. G. C. Champion, that "*Acanthomeræ* are found in forests, alighting on trunks of trees." In the year referred to, however, Karl Fiebrig, of San Bernardino, Paraguay, working under the disadvantages contingent upon isolation and lack of entomological literature, published a most interesting account (*cf.* "Bibliography," p. 552), illustrated by a series of figures, of the external and internal anatomy of the larva of *Pantophthalmus pictus* Wied. (*infra*, p. 575). From the larvæ found by him, Fiebrig succeeded in breeding out a pair of imagines, which, owing to the disadvantageous conditions just mentioned, he regarded as belonging to a new species, and accordingly described under the name *Acanthomera teretruncum*.

Thanks to Fiebrig's observations, which were actually made in 1905, and were confirmed seven years afterwards by Mr. F. W. Urich, in Trinidad, in the case of another species (*Pantophthalmus tabaninus* Thunb.), we now know that larvæ of Pantophthalmidæ have the extraordinary habit—unique among Diptera, so far as the present writer is aware—of boring in the solid wood of living trees, in which they make "nearly horizontal" tunnels, and feed upon the exuding sap. Although Fiebrig does not mention the name of the tree in which he found his larvæ, he states that its wood is "among the toughest of Paraguayan timbers, hard as these in general are," and that the tunnels made by the maggots are "sharply gouged out."

In view of Fiebrig's detailed account, which should be consulted by the student, it is scarcely necessary here to do more than draw attention to the accompanying figure (text-fig. 1), which displays the chief features in the external morphology of a larva—probably nearly adult—of another species of the genus *Pantophthalmus.* This larva, which is preserved in spirit, is 32·5 mm. (just over $1\frac{1}{4}$ inch) in length, while the average ventro-dorsal diameter of the body-segments is 9·75 mm. It was taken, with at least five other larvæ of the same kind, in the Island of Trinidad, B.W.I., in borings in the trunk of an *Erythrina*, a leguminous tree, which attains a height of from 15 to 20 feet.

Text-figure 1.



Larva of *Pantophthalmus tabaninus* Thunb. (lateral view), from boring in trunk of *Erythrina* tree (*E. corallodendrum* L. ?), Trinidad, B.W.I., March 1912 (*F. W. Urich*). × $2\frac{1}{2}$.—From specimen kindly lent by Dr. Hugh Scott, University Museum of Zoology, Cambridge.

a, labrum; *b*, left mandible; *c*, left anterior (prothoracic) spiracle or stigma; *d*, dorsum of 8th post-thoracic segment, which is very heavily chitinized; *e*, Fiebrig's "finger-shaped bodies"—in all probability an auxiliary respiratory apparatus, employed when the posterior stigmata are unable to function, owing to the larval tunnel being full of sap.

The stout labrum and the extremely powerful mandibles together form a "drill," by means of which the larva is able to bore in solid wood; the equally heavily chitinized dorsum of the 8th post-thoracic segment closes the tunnel from behind, and protects the larva from an attack in the rear. The posterior stigmata open on the posterior (ventral) surface of this segment, in a mouth-like chamber between it and the 9th post-thoracic segment, which bears the "finger-shaped bodies." When the latter segment is in the position shown in the figure, the posterior stigmata are completely closed.

In the adult Pantophthalmid larva, the number, size, and arrangement of the backwardly directed spines on the 8th post-thoracic segment perhaps afford characters of specific importance (*cf.* Brauer, *loc. cit.* Taf. ii. figs. 25 *a*, 25 *b*).

In the Trinidad larva, the longitudinal strips of chitin embedded in the integument of the prothoracic segment, to which the striped appearance of the latter is due, are reddish brown, while the powerfully developed labrum and mandibles, and the heavily chitinized dorsal surface of the 8th post-thoracic segment are deep black; the prevailing tint of the remainder of the body is that of old ivory. There can be little doubt, however, that prolonged immersion in alcohol has had a bleaching effect, since Fiebrig describes the nine "soft" body-segments in the larva discovered by him as "bluish green," owing to the "intense blue tint" of the abundantly developed fat-body; it is also worthy of note that in life, according to the same author, the "finger-shaped bodies" (see text-fig. 1 and explanatory text) are bright green. The dorsal surface of the prothoracic segment, though far less heavily armoured than that of the 8th post-thoracic segment, nevertheless, strengthened as it is in the manner already referred to, is quite hard, and may well serve to protect the tunnelling larva against possible injury from sharp splinters of wood.

An interesting point with reference to the living larva of *Pantophthalmus pictus* is noted by Fiebrig, who writes that, "when in the tree-trunk it produces rasping sounds, distinctly audible up to a distance of some four paces."

The pupal envelope, according to the same observer, is vertically truncated at each end, "the anterior extremity being formed by a stout, richly sculptured plate of chitin," which serves to protect the pupa from a frontal attack. Although this armoured shield is not broken through by the imago in emerging, it may be that the facial "beak," that is so conspicuous a feature in many Pantophthalmidæ though not exhibited by all species, or always developed in both sexes, when present assists the fly in making its escape from the pupal envelope. The latter, we are told by Fiebrig, "after the emergence of the imago, projects about halfway out of the larval tunnel"; but the same authority is unable to state whether the pupa makes its way to this point by its own efforts, or whether the pupal envelope is dragged along with it by the escaping fly.

"Metamorphosis," writes Fiebrig, "appears to be very protracted. A larva 35 mm. in length, and apparently nearly full-grown, was kept under observation from July 31, 1905, onwards. The imago emerged in the afternoon of January 11, 1906, a few weeks before which date it was found that the insect was still in the larval state; this would point to a pupal stage of very short duration."

Whether larvæ of Pantophthalmidæ are of economic importance, as destroyers of timber of commercial value, is an interesting point which awaits determination. So far as can be ascertained, the wood of *Erythrina* (*E. corallodendrum* L.?), in which the larvæ of *Pantophthalmus tabaninus* Thunb. were found by Mr. F. W. Urich, in Trinidad, is of little or no utility. But the possibility of commercial value is at any rate not excluded in the case of the unknown Paraguayan tree referred to by Fiebrig, as to which we are told that the wood is exceedingly hard and extremely rich in sap, "yielding an abundance of evil-smelling fluid on being injured."

(g) *Pseudo-Parasites.*

Pseudo-parasites in the shape of Gamasid mites are of extraordinarily common occurrence on Pantophthalmidæ, and many instances of such infestation are recorded in the following pages. The mites, on being submitted by the author to his colleague Mr. A. S. Hirst, F.Z.S., for identification, were found by him in every instance except one to be conspecific, and to be nymphs of a species of *Trachytes*, which Mr. Hirst will describe in a forthcoming paper as new (*cf.* p. 565). In the single case forming the exception, the pseudo-parasite was determined by Mr. Hirst as an adult female of *Macrocheles*, sp. incert. (*vide* p. 588). It would seem that these pseudo-parasites must infest the borings of the larvæ, and attach themselves to the flies as the latter emerge from the pupa-case.

(h) *Systematic Portion.*

Taking into account synonymy already established, the total number of species of Pantophthalmidæ at present recognized amounts to twenty-four. In the following pages ten species, previously described by various authors, are admitted as valid and commented upon, notes being given on the specimens of these species in the British Museum (Natural History), or otherwise available to the writer for examination; the names of nine other species, hitherto accepted, are sunk as synonyms; and six species and one genus are described as new. As the result of this paper, therefore, the number of known species of Pantophthalmidæ, including those that the author has been unable to examine, will stand at twenty-one. It is explained below that, in agreement with Kertész, and contrary to the course adopted by Enderlein, the genus *Pantophthalmus* Thunb. is treated as including *Acanthomera* Wied. In view of the limited amount of material at the author's command, and since as yet both sexes are known in the case of only a minority of species, with much regret no attempt has been made to construct a synoptic table. Should the publication of the present paper fortunately result in a considerable expansion of the National Collection of these interesting Diptera, the construction of a reliable table of the kind in question may eventually be possible.

Genus **Pantophthalmus** Thunberg.

Pantophthalmus Thunberg, Götheborgs Kongl. Wettenskaps och Witterhets Samhällets Nya Handlingar, iii. Delen, p. viii (1819).

Acanthomera Wiedemann, Diptera Exotica, Pars i. p. 60 (1821).

Megalomyia Bigot, Ann. Soc. Ent. France, 5e Sér., T. x., Bull. p. v (1880).

Megalemyia Bigot, Ann. Soc. Ent. France, 6e Sér., T. i. p. 455 (1881).

After due consideration, it has seemed better to follow Kertész (Cat. Dipt. iii. p. 294 (1908)), who gives the synonymy printed above, rather than Enderlein (Zool. Anz., Bd. xli. p. 100 (1912)), by whom *Pantophthalmus* Thunb. and *Acanthomera* Wied. are treated as generically distinct. The course adopted by Kertész appears the more reasonable one under the circumstances, in spite of lack of complete agreement among the species mentioned or described in the following pages, in respect of certain structural details. Included among the latter are:—The degree of development of the facial "beak"; the shape of the terminal segment of the maxillary palpus; the shape of the terminal division of the third (compound) segment of the antenna in the female; and the presence or absence of a distinct subfemoral spine on the hind legs.

Although, by concentrating attention on one or other of these characters and disregarding the remainder, it would perhaps be possible in the case of certain species to select distinctions of apparently generic value, yet in other forms intergradations occur which make the drawing of a hard and fast line of demarcation impossible. Thus, to take only one of the characters referred to:—Enderlein (*loc. cit.* p. 99), writing of the terminal division (called by him the tenth segment) of the female antenna, says that this "in *Pantophthalmus* tapers gradually to a point, but in *Acanthomera* and *Rhaphiorhynchus* becomes but little narrower towards the end, and then, just before the tip, is suddenly pointed." This statement is certainly true if we compare the antenna of the female in species such as *Pantophthalmus tabaninus* Thunb., or *P. bellardii* Bell. (both of which belong to *Pantophthalmus*, sensû stricto) with that of the female of e.g. *Pantophthalmus* (*Acanthomera*) *chuni* Enderl. But when we examine the antenna in the female of *Pantophthalmus pictus* (*Acanthomera picta*) Wied.—a species with a well-marked subfemoral spine, and the genotype of *Acanthomera*—we find that it is intermediate between the two conditions. Moreover, in the female of *Pantophthalmus vittatus* (*Acanthomera vittata*) Wied.—a species assigned by Enderlein himself (*loc. cit.* p. 107) to *Pantophthalmus*—the terminal division of the antenna is precisely of the type regarded by Enderlein as characteristic of *Acanthomera*.

As regards the maxillary palpus, the terminal segment of this structure is also subject to a certain amount of variation in shape in different species. Although usually slender and cylindrical, and, at least in the female sex, longer than the remainder of the palpus, it is sometimes shorter and also stouter, albeit never swollen in the manner characteristic of the terminal segment of the palpus in *Rhaphiorhynchus*.

That Enderlein is in error when he asserts (*loc. cit.* p. 100) that in *Pantophthalmus*, sensû stricto, the facial beak is represented merely by a "rounded tubercle-like swelling" is pointed out by Hermann (Deutsche Ent. Zeitschr., Jahrg. 1916, p. 48 (1916)), who shows that in *P. alienus* Herm. the absence of a subfemoral spine on the hind legs is correlated with the presence of a "long, pointed, tooth-like facial process." A further example of the condition seen in *P. alienus* Herm. is afforded by the new species described below as *P. batesi* (*cf.* p. 566), in the male of which, at any rate, while the facial beak, though small, is conspicuous and sharp-pointed, the posterior femora are either without a spine on the under surface, or display the merest vestige of such a structure.

The truth is that characters such as those mentioned above, however valuable for the distinction of species, are of less than generic importance, and, were it necessary, many arguments in support of this contention might be furnished from the accepted taxonomy in other families of Diptera.

Among characters of *specific* importance in the genus *Pantophthalmus*, may be mentioned *wing-markings* and, although this does not apply to the males of certain species which have the thorax unicolorous or nearly so, *the markings on the dorsum of the thorax.*

Wing-markings, in spite of their general similarity (with certain exceptions) throughout the family Pantophthalmidæ, will be found, if close attention be paid to details, to afford useful assistance not only in the distinction of species, but in the correct association of the sexes of the same species—a matter in some cases probably of far greater difficulty. Osten Sacken, in the course of a valuable disquisition on structural peculiarities and characters of specific importance in Pantophthalmidæ ("Acanthomeridæ," Biol. Centr.-Amer., Diptera, i. pp. 65–66 (1886)), does not refer to wing-markings, but writes as follows with regard to markings on the thorax :—"The arrangement of the stripes and spots on the thorax, an apparent monotony notwithstanding, offers excellent characters for the recognition of the species, and especially for the assorting together of male and female specimens of the same species." As regards the value of thoracic markings for the association of the sexes of a given species, the statement just quoted is only partially true. It certainly hold goods in the case of *Pantophthalmus tabaninus* Thunb. (the synonymy given on p. 562 below is based on and supported by the characteristic thoracic markings exhibited by this species), and *P. vittatus* (*Acanthomera vittata*) Wied. (as also in that of *Rhaphiorhynchus planiventris* Wied.); but it is entirely inapplicable to a species such as *Pantophthalmus pictus* (*Acanthomera picta*) Wied., in which the dorsum of the thorax is conspicuously striped in the female, but almost uniformly silvery, or at any rate without corresponding stripes, in the male. While the presence of sharply-defined, dark longitudinal stripes on the dorsum of the thorax (scutum) is characteristic of the female sex in *Pantophthalmus* (and also in *Rhaphiorhynchus*), there are, in addition to *P. pictus* Wied., at least three species, including one described for the first time in the following pages, in which, while the female is as yet unknown, the thorax in the male is without such stripes. In these species the dorsum of the male abdomen, be it noted, has a silvery sheen. It is to be hoped that males and females of the species in question may ere long be caught *in coitû*, or bred from larvæ or pupæ taken in the same tree-trunk, otherwise the correct association of the sexes in these cases may remain a matter of doubt for an indefinite period.

In addition to sexual dimorphism of the kind just referred to, difficulties of determination in this genus are increased by the fact that in the case of certain species (at any rate *P. tabaninus* Thunb. and *P. pictus* Wied.—see below) the female abdomen, at least in dried specimens, sometimes shows colour-dimorphism as well. Failure to realize the occurrence of this phenomenon led Enderlein into error in constructing his synoptic tables (Zool. Anz. xli. pp. 101, 107 (1912))—a fact which has already been pointed out by Hermann (Deutsche Ent. Zeitschr., Jahrg. 1916, p. 48 (1916)).

The number of species of *Pantophthalmus* recognized as valid in Kertész's 'Catalogus' (vol. iii. 1908) is fourteen. This total does not include *Acanthomera teretruncum* Fiebrig (=*Pantophthalmus pictus* (*Acanthomera picta*) Wied.), since the description of the latter (1906) appeared between the compilation and publication of the volume of the late Dr. Kertész's monumental work in which the Pantophthalmidæ are included. Between 1908 and the present time, descriptions of nine species of *Pantophthalmus* supposed to be new have been published, including seven by Enderlein and one each by Hermann and Knab; while Enderlein has rightly sunk Fiebrig's designation *Acanthomera teretruncum* as a synonym, besides disposing of *P. helleri* Enderl. in a similar manner. Thus for the moment the number of species of *Pantophthalmus* assumed to be valid stands at twenty-two. In the following pages, however, the names of no fewer than nine of these are shown to be synonyms, while six species are described as new; so that, as the result of the present paper, the genus *Pantophthalmus* is to be regarded as consisting of nineteen recognized species.

The genotype is *Pantophthalmus tabaninus* Thunb.

Pantophthalmus tabaninus Thunb.

Pantophthalmus tabaninus Thunberg, *loc. cit.* p. vii (1819).

Acanthomera seticornis Wiedemann, Auss. zweifl. Ins. i. p. 108, Taf. ii. figs. 1 *a*–1 *c* (1828). [New synonym.]

Acanthomera heydenii Wiedemann, *op. cit.* p. 555 (1828). [New synonym.]

Acanthomera immanis Wiedemann, *op. cit.* ii. p. 623 (1830). [New synonym.]

Acanthomera rubriventris Bigot, Ann. Soc. Ent. France, 5e Sér., T. x., Bull. p. v (1880). [New synonym.]

Pantophthalmus fastuosus Knab, Insec. Inscit. Mens. vol. ii. no. 2, p. 27 (February 1914). [New synonym.]

According to Thunberg (*loc. cit.*), the type of *P. tabaninus* was obtained in St. Barthélemy I., in the West Indies.

Among the synonyms recorded above, the name *Acanthomera seticornis* (like *Pantophthalmus tabaninus* itself) was originally applied to the ♂ insect, while the designations *Acanthomera heydenii*, *A. immanis*, and *A. rubriventris* were bestowed upon the ♀. A study of the thoracic markings, which are characteristic of this species and present a striking agreement in both sexes, leaves no doubt as to the correctness of the synonymy here given. In spite of the fact that *Pantophthalmus gigas* Enderlein (Zool. Anzeiger, Bd. xli. p. 110, fig. 7 (1912)), described from the ♀ sex, is stated by its author (*loc. cit.*) to be devoid of pale spots on the lateral margins of the second and third abdominal tergites, it would seem not unlikely that this supposed species is also identical with *P. tabaninus* Thunb.

The representatives of *Pantophthalmus tabaninus* Thunb. at present contained in the British Museum (Natural History) are as follows:—One ♂, (?) Trinidad, B.W.I. (*G. Robertson—ex coll.* W. W. Saunders); one ♀, Venezuela, before 1847 (purchased from — Dyson); one ♀, Brazil, before 1849 (*Mrs. Noel*); one ♂, locality unknown (*ex coll.* Alexander Fry); one ♂, Trinidad, B.W.I., before 1878 (*Mrs. Cutter*); one ♂, Macapá, R. Amazons, Brazil, 25. ii. 1896 (*E. E. Austen*), "on board Messrs. Siemens Bros.' Cable S.S. *Faraday*"; one ♀, Nicaragua (*E. A. Burns*); one ♀, Colonia Hansa, Santa Catharina, Brazil (purchased from H. Rolle). Presented by Mr. J. E. Collin, F.E.S., from the Bigot collection, we also have the four specimens (including the type) of *Acanthomera rubriventris* Big., which are all ♀ ♀ from Guatemala; and two ♂ ♂ of *P. tabaninus*, likewise from Guatemala, which, in Bigot's series, were placed with a ♂ of *P. versicolor* Austen (see below), above the label "*Acanthomera seticornis*, Wied. ♂," in Macquart's handwriting.

The Hope Department of the University Museum, Oxford, possesses two ♂ ♂ and two ♀ ♀ of *P. tabaninus*; of the former, one specimen is labelled "*seticornis* Wied.," but is without any indication as to provenance, while on the label of the other is written "Pará. Higgins, 1868"; there is nothing to show the origin of the two ♀ ♀, which are labelled "*R. planiventris.*"

The Liverpool School of Tropical Medicine has a ♀ of *P. tabaninus* from Pará, Dec. 1922 (*Dr. Clarke*).

In this species, in which the female usually, although not invariably, much exceeds the male in size, the ground-colour of the dorsum of the abdomen ranges from cinnamon-rufous * or vinaceous-rufous to blackish-brown or black. The dark thoracic stripes are the same in all cases, and, at least in the specimens available to the writer for examination, the silvery-white triangular spot near each posterior angle of the second and third abdominal tergites is always visible, although in some individuals less conspicuous than in others. In the case of the type of *P. tabaninus*, which, from the details furnished by Thunberg, is evidently a male, the dorsum of the abdomen, according to the original description, is "brown"; Wiedemann (*loc. cit.*) describes the dorsum of the abdomen in *Acanthomera seticornis* as "vivid

* For names and illustrations of colours used for descriptive purposes in the present paper, see Ridgway, 'Color Standards and Color Nomenclature' (Washington, D.C. Published by the Author, 1912).

ferruginous-yellow" (sehr brennend rostgelb), and the same region in *A. immanis* as "ferruginous." In the type of *A. rubriventris* Big. the ground-colour of the first four abdominal tergites is between ferruginous and vinaceous-rufous, while the hind borders of the second and third tergites, and the hind border of the fourth tergite except its lateral extremities, are black. Of the three paratypes of *A. rubriventris*, one agrees with the type in the coloration of its abdomen, while in the case of the other two the dorsum of the abdomen is reddish-brown. In the series of specimens of *P. tabaninus* in the National Collection, other than those just mentioned under Bigot's designation *Acanthomera rubriventris*, the six males have the dorsum of the abdomen (except its basal angles and the lateral borders of the first three tergites, which are black in this sex) cinnamon-rufous, vinaceous-rufous, or ferruginous, while the venter is seal-brown. Of the four females comprised in the same series, one has the dorsum of the abdomen (except the lateral margins, which are black) dull amber-brown, while in the case of the other three individuals the corresponding region is for the most part blackish-brown; the venter in each specimen is dark seal-brown. Among the four examples of *P. tabaninus* in the possession of the Hope Department, University Museum, Oxford, the two males have the dorsum of the abdomen cinnamon-rufous, apart from the black lateral borders of the first three tergites, and the basal angles of the fourth tergite, which are brown or blackish-brown. In one of the two females in the Oxford collection, the dorsum of the abdomen, with the exception of the small silvery-white spot near each posterior angle of the second and third tergites, is uniformly velvety-black. The corresponding region in the other specimen is brownish black, with an ochraceous-tawny transverse area in the centre of the hind border of the first segment, extending on to the front margin of the second; on the latter segment there is also a deep, brownish-tawny, transverse band, which is not very sharply defined, and does not reach the lateral extremities of the tergite; on both the second and third tergites, in front of the hind margin, there is a black transverse band.

It is interesting to note that, in the case of one of the females of *P. tabaninus* in the National Collection (the specimen referred to above as having been taken in Brazil prior to 1849, by Mrs. Noel), the abdomen shows a very heavy infestation by nymphs of a Gamasid mite. The pseudo-parasites, which, in the dried condition at any rate, are light ochraceous-buff in colour, and measure about 0·4 mm. in length, are present to the number of many hundreds on the dorsal surface of the abdomen, where they are packed so closely as to form large patches, while quantities are to be seen crowded together beneath and partially concealed by the hind margins of the tergites. Further specimens of the mite, although in small numbers as compared with those on the dorsum, are also visible on the venter. The male *P. tabaninus* taken by the writer at Macapá, R. Amazons, 25. ii. 1896, on board the Cable S.S. *Faraday*, shows a considerable number of what is evidently the same pseudo-parasite on the dorsal surface of its abdomen, while many instances of similar infestation in the case of specimens of other species of Pantophthalmidæ are noted below. Since therefore, even among the limited series of these flies available to the author for examination, representatives of various species are infested in this manner, it would seem that for some reason members of this family are peculiarly subject to to invasion by this Acarid. The author's colleague, Mr. A. S. Hirst, F.Z.S., to whom the mites have been submitted, has kindly supplied the following note:—"The pseudo-parasites are nymphs of a species of *Trachytes*, a Gamasid mite, and presumably are predatory forms, possibly feeding upon small mites or insects inhabiting the tunnel of the fly-larva. This habit of attaching itself to an insect host is no doubt of benefit to the mite, by widening its area of distribution."

Pantophthalmus frauenfeldi Schin.

Acanthomera frauenfeldi Schiner, Reise der österreichischen Fregatte 'Novara' um die Erde, Zool. Theil, Bd. ii. Diptera, p. 78 (1866).

Of this species, the National Collection possesses a ♀ from Bogota, Colombia (*ex coll.* — Stevens, 1856), in which country the type was obtained; and a second ♀, from Peru (*ex coll.* J. M. F. Bigot; presented by J. E. Collin). The latter specimen, with the type of *Acanthomera crassipalpis* Macq. (=*Rhaphiorhynchus planiventris* Wied.), and two other ♀♀ of *Rhaphiorhynchus planiventris* Wied., stood in the Bigot collection above the label "*Acanthomera crassipalpis*, Macq., n. sp. ♀," in Macquart's handwriting.

Including the facial beak and ovipositor, the original Museum specimen measures just over 31 mm. in length, instead of 35 mm., which is the length of the type (also a ♀) as given by Schiner. The total length of Bigot's example, measured in the same way, is 32 mm.

In the Hope Department, University Museum, Oxford, there is a solitary ♀ of *P. frauenfeldi* from Macas, Ecuador (purchased from Stevens, 1862). The dimensions of this specimen, which is very much larger than the examples in the National Collection, are as follows:—Total length, including facial beak and ovipositor, 42·25 mm.; greatest width of abdomen (across hind margin of second tergite) 16·25 mm.; wing-expanse 74·6 mm. The terminal segment of the palpi in the Oxford specimen is slender, straight and cylindrical, whereas the corresponding segment in the British Museum ♀ from Bogota is curved outwards at the tip and distinctly swollen towards the base; in the ♀ from the Bigot collection the palpi are damaged.

Two nymphs of the usual species of Gamasid mite (*cf.* remarks under *P. tabaninus* above) are visible on the dorsum of the abdomen of the ♀ from Bogota.

Pantophthalmus batesi, sp. n. (Text-fig. 2.)

♂.—Length (one specimen) 24 mm.; width of head 6·4 mm.; greatest width of abdomen (across hind border of second tergite) 8 mm.; length of wing 18·5 mm.

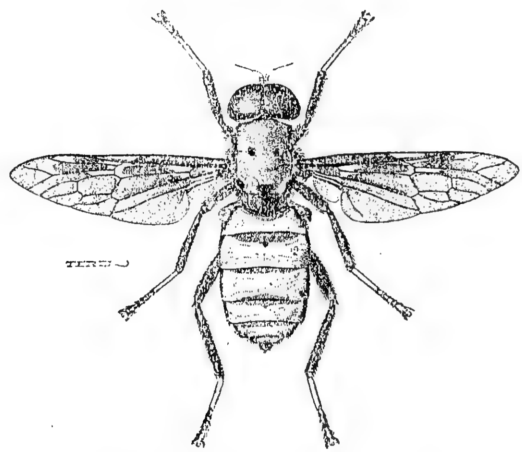
Relatively small and (in ♂ sex at least) somewhat narrow-bodied species, with, in ♂, a small but conspicuous, sharp-pointed facial "beak," unstriped thorax, and ochraceous-orange abdomen, which along each lateral margin bears a series of sooty-black spots or elongate blotches, and dorsal surface of which, except anterior borders of second to fifth segments inclusive, has from certain angles the appearance of burnished silver; wing-markings presenting a general resemblance to those of P. tabaninus *Thunb., but with conspicuous differences, notably a curved pale mark connecting fork of third longitudinal vein with costa; posterior femora without, or with merest vestige of, a spine on under surface.*

Head in ♂ sex more flattened in an antero-posterior direction than that of *P. tabaninus* Thunb., and consequently less hemispherical in outline when viewed from above; face, except beak, dusky drab; jowls and basi-occipital region clove-brown, clothed with similarly coloured hair; occiput olive-buff; facial beak blackish brown at base, distal attenuate portion chestnut-brown; *palpi* light sepia-coloured, darker towards distal extremities; second segment * clothed beneath, towards distal extremity, with blackish-brown hair, terminal segment curved, slender, tapering to the tip; first and second segments of *antennæ* russet-coloured, first segment thinly clothed with brownish hair, second segment with some glistening orange-buff hair on distal margin (third segment missing in case of type). *Thorax*: ground-colour of dorsum cinnamon-drab, thinly suffused above with smoke-grey pollen, while lateral borders of dorsum are olive-buff pollinose; main portion of dorsum (scutum) marked with five dull-black spots, of which two, smaller than remainder and nearly circular, are situated on line of transverse suture, one on each side of middle line; remaining spots transversely elongate and situated on hind border, one in middle line, the other two occupying the postalar calli, except inner extremities of latter; scutellum dull-black or blackish-brown, anterior angles and lateral borders smoke-grey pollinose; pleuræ and pectus blackish-brown and

* *Note on the number of segments in the maxillary palpus in* Pantophthalmidæ.—Fiebrig (Zeitschr. f. wiss. Insektenbiol., Bd. ii. p. 346, 1906), in describing the species named by him *Acanthomera teretruncum* (=*Pantophthalmus pictus* (*Acanthomera picta*) Wied.), speaks of "the relatively long, three-jointed palpi." Williston (North American Diptera, 3rd Ed., p. 173, 1908), in a short general account of the "Family Acanthomeridæ," states that the palpi are "two-jointed." Lastly Enderlein (Zool. Anz., Bd. xli. p. 99, 1912) says that in Pantophthalmidæ, owing to the irregular transverse wrinkling of the palpus basad of the terminal segment, it is impossible to determine whether this portion is further segmented or not. There can be no doubt, however, that the maxillary palpus in this family consists of three segments, in which, while the second is often marked by conspicuous annuli or transverse wrinkles, the first owing to its shortness may easily be overlooked, although in many species distinguishable by darker coloration and a different arrangement of the hair.

clothed with fine similarly coloured hair, dorsum, and lateral extremities of pronotum, clothed wtih ochraceous-buff hair. *Abdomen*: first tergite with each lateral extremity broadly black, though just in front of hind margin of segment black area shows a deep indentation of ground-colour above and below; second and third tergites with a scutiform or elongate black spot occupying each anterior angle, extreme hind margins of posterior angles of second tergite also black; fourth tergite with anterior two-thirds of lateral extremities sooty black; lateral extremities of fifth tergite blackish-brown; sixth tergite entirely ochraceous-orange; a straight transverse band running right across fore border of fifth tergite devoid of silvery sheen; on each of the three preceding tergites corresponding non-silvered band tapers towards lateral extremities of the tergite, which it fails to reach,

Text-figure 2.



Pantophthalmus batesi Austen, ♂. × 1½.

while its hind margin, which exhibits a backwardly directed projection in middle line, is more or less brace-shaped; lateral extremities of tergites clothed on dark areas with dark brown or blackish-brown hair, and elsewhere clothed with yellowish, cinnamon-coloured, or brownish hair, remainder of dorsum clothed with minute, scattered, and very inconspicuous cinnamon-buff hairs, which on sixth tergite are somewhat longer; venter orange-buff, partially suffused with a silvery sheen (especially distinct on first three sternites), and sparsely clothed with hair similar in colour to that on dorsum, but longer. *Wings* light sepia-coloured, marked as shown in fig. 2, the most conspicuous markings being those on the costal border, consisting of two irregularly shaped dark blotches and two cream-buff or pinkish-buff marks; of the latter, the one nearer the base of the wing, which extends from the costa to the upper distal angle of the second basal cell and includes the anterior transverse vein, resembles the corresponding mark in the wing of *P. tabaninus* Thunb., but is more sharply defined; the veins separating the second posterior marginal cell from the discal cell, and the fifth posterior marginal cell from the second basal cell are each enclosed in a sharply defined, cream-buff spot; a faint, elongate, cream-buff spot is visible on the sixth longitudinal vein, in the centre of the lower margin of the anal cell, and both basal cells are cream-buff at the base; veins sepia-coloured, except in the lighter areas where they are cinnamon-buff or pinkish-buff, first longitudinal vein where enclosed in more distal of the two dark costal areas, and fifth longitudinal vein except at base and tip of second basal cell, darker than most other veins or portions of veins. *Halteres* cinnamon-buff. *Legs*: hind femora slightly incrassate towards distal extremity; femora, front and middle tibiæ, and last four segments of all tarsi russet, russet-brown. or chocolate-brown, hind tibiæ blackish-brown, first segment of all tarsi bright mustard-yellow, narrowly russet-brown at extreme tip, last segment of all tarsi russet, paler than three preceding segments; claws russet-brown at base, then blackish-brown or black; pulvilli and empodia ochraceous-buff or ochraceous-tawny; femora, front and middle tibiæ, and second and two following segments of all tarsi clothed mainly with russet-brown, dark-brown, or blackish-brown hair, first segment of all tarsi except extreme tip clothed with glistening Naples-yellow hair, inner and flexor surfaces of front tibiæ, anterior and posterior surfaces of proximal portion of hind femora, and last segment and extreme tip of first segment of all tarsi clothed with russet-brown or chestnut-brown hair, hind tibiæ fairly thickly clothed with blackish-brown or black hair, which, except hair on flexor surface of hind femora, is longer than hair on legs elsewhere.

Brazil: Villa Nova, R. Amazons (*H. W. Bates*).

The species described above, which is dedicated to the memory of its discoverer, the well-known author of 'The Naturalist on the River Amazons,' is readily distinguishable from any of its congeners included in the present paper. From *P. tabaninus* Thunb., in addition to the points of difference to which special attention has been shown in the foregoing description, *P. batesi* is separable, *inter alia*, owing to its unstriped thorax, and, at any rate in the ♂ sex, the silvery sheen on the dorsum of the abdomen. From the two following species, in both of which, at least in the ♂, the dorsum of the abdomen is likewise "silver-washed," *P. batesi* may be distinguished in the same sex, *inter alia*, by its abdomen being narrower and spotted with black along the lateral margins. From *P. hellerianus* Enderl., of which a re-description is given below, *P. batesi* is further distinguishable, owing to its much more clearly marked wings, to the presence of dark spots on the thorax, and to the surface of the latter not being silvery.

Pantophthalmus hellerianus, Enderl. (Text-fig. 3.)

Acanthomera helleriana Enderlein, Zool. Anz., Bd. xliv. no. 13, p. 581 (July 28, 1914).

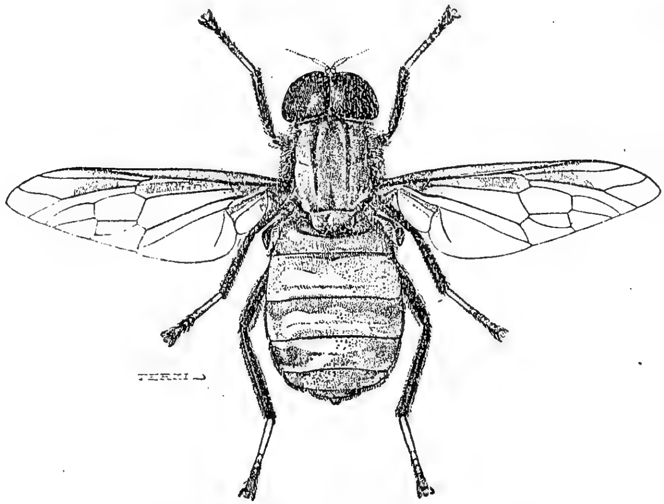
Since the original description of this species, which is at present only known in the male sex, in some respects requires amplification, *P. hellerianus* Enderl. is redescribed below. In the case of the specimen in the National Collection, at any rate, the brown or greyish-brown, **W**-shaped mark on the dorsum of the thorax, on which Enderlein lays stress, is only visible when the insect is viewed at a fairly low angle from behind, and even then it is not very distinct.

♂.—Length (one specimen) 29·5 mm.; width of head 8·4 mm.; greatest width of abdomen (across third tergite) 12·2 mm.; length of wing 23·2 mm.

Dorsal surface of both thorax and abdomen, at least in ♂, "washed" with silver, which on thorax is duller, but on abdomen has a more pronounced silken sheen; facial "beak" very small and inconspicuous; dorsum of thorax (scutum), when viewed from certain angles, with more or less distinct traces of longitudinal stripes; dorsum of abdomen unicolorous, without definite lateral spots, broad, flat, and somewhat ovate pyriform in outline when viewed from above, with sharp edges to third and following tergites; wings pale, with (except when viewed against a dark background) faint, ill-defined markings; hind legs with a small subfemoral spine.

Head in ♂ distinctly flattened in antero-posterior direction; upper portion of face, except immediately adjacent to bases of antennæ, isabella-coloured; remainder of face, including base of beak, as also jowls and basioccipital region, dark mummy-brown or blackish-brown, tip of beak, which scarcely protrudes beyond enveloping hood formed by base, chestnut-brown, shining; occiput cream-buff pollinose; jowls clothed with brownish or dark brown hair, with an ochraceous-tawny gleam at base, basioccipital region clothed with ochraceous-tawny hair; first and second segments of *palpi* greyish cinnamon-brown, clothed with dark brown hair, terminal segment tawny or cinnamon-rufous, curved, slender, and tapering; first segment of *antennæ* mummy-brown, second segment tawny, fringed below with minute, ochraceous-buff hairs (third segment missing in specimen described). *Thorax*: dorsum of main portion (scutum), when viewed at an angle from behind, exhibiting a pair of admedian, darker (shimmering greyish-olive), longitudinal stripes, commencing on fore border, converging and diminishing somewhat in width as they proceed backwards, and becoming narrower and indistinct after passing transverse suture; posterior portion of scutum with a similar, median, longitudinal stripe, commencing in prescutellar groove and tapering off and disappearing about halfway between latter and transverse suture; dorsum of scutum clothed with fine yellowish hair; scutellum, which, except on anterior angles, is mainly sepia-coloured, clothed with similar hair; outer extremities of humeral calli cinnamon-rufous, shining, a ridge of fairly long, shining, tawny-olive or cinnamon-buff hair on each side of dorsum, connecting humeral with corresponding postalar callus, postalar calli mainly mummy-brown, clothed with similarly coloured hair; pleuræ and pectus mummy-brown, clothed with hair of similar colour, a tuft of bright ochraceous-tawny hair on each side, in prothoracic region. *Abdomen*: ground-colour of dorsum russet, lateral extremities of first tergite broadly, and those of fourth tergite narrowly sepia-coloured, anterior angles of second and third tergites similarly tinted; first tergite clothed with fine cinnamon-buff hair, longer and more conspicuous on lateral

Text-figure 3.



Pantophthalmus hellerianus Enderl., ♂. × 1½.

extremities, where, except on anterior angles, it has an ochraceous-tawny tinge; lateral extremities of second tergite clothed with fine, short, appressed, cinnamon-buff hair (sepia-coloured area occupying each anterior angle clothed with shining cinnamon-brown hair); lateral extremities of third and two following tergites fringed with cinnamon-brown hair; sixth tergite largely clothed with similar hair, which is longer on hind border; venter uniformly tawny. *Wings* pale mouse-grey, first costal and subjacent cell mummy-brown or sepia-coloured, two dusky (dusky-drab), more or less quadrate blotches on costal border, separated by cream-buff interspaces; proximal blotch including rather less than distal half of first basal cell, but not extending to tip of latter; distal blotch, which in specimen described at least is the darker of the two, including distal sixth or seventh of first longitudinal vein, and area immediately below as far as third longitudinal vein; tip of wing, including distal portion of first submarginal and entire second submarginal cell, except its extreme base, somewhat darker than hind border (when viewed against a light background), and separated from distal costal blotch by an ill-defined and irregular pale area; costa ochraceous-tawny or light cinnamon-brown (mummy-brown at base and above distal costal blotch), remaining veins cinnamon-brown, ochraceous-tawny or ochraceous-buff (in darker areas corresponding in tint to adjacent membrane). *Halteres*: stalks cinnamon-buff, knobs blackish-brown. *Legs*: hind femora of uniform thickness (not incrassate towards distal extremity); femora and tibiæ russet-coloured, clothed with fine, dark brown hair, flexor surfaces of front tibiæ clothed with short, glistening, ochraceous-tawny hair; first segment of front and middle tarsi ochraceous-buff (cinnamon-brown at extreme tips on flexor surface), first segment of hind tarsi cream-buff (light cinnamon-brown at extreme tips on flexor surface), last four segments of all tarsi ochraceous-tawny, clothed with minute, appressed hairs of similar colour; claws rufous-tawny at base, then black; pulvilli and empodia ochraceous-buff.

One ♂, Brazil: R. Amazons (precise locality unknown) (*H. W. Bates*).

Pantophthalmus hellerianus, which, in the ♂ sex at any rate, agrees with *P. argyropastus* Big., in having the dorsal surface of the abdomen silvery, is readily distinguishable from that species, *inter alia*, by the dorsum of the main portion of the thorax being not only much paler but also devoid of dark spots (*cf.* notes on *P. argyropastus* below). For distinctions from *P. batesi* Austen, *vide supra*, p. 568.

Finally it may be added that the example of *P. hellerianus* in the National Collection exhibits, on the dorsal surface of its abdomen, several specimens of the pseudo-parasitic Acarid mentioned in the present paper in connection with *P. tabaninus* Thunb., and other species; in this case there is also a number of very much smaller mites on the dorsum of the thorax.

Pantophthalmus argyropastus Big.

Megalomyia argyropasta Bigot, Ann. Soc. Ent. Fr., 5ᵉ Sér., T. x., Bulletin, p. v (1880).

Megalemyia argyropasta Bigot, Ann. Soc. Ent. Fr., 6ᵉ Sér., T. i. pp. 455, 458 (1881).

An examination of the holotype male of this species, formerly in the Bigot collection and presented to the British Museum (Natural History) by Mr. J. E. Collin, F.E.S., shows that, in spite of Bigot's misleading statement to the effect that the thorax is marked with "three, somewhat indistinct, blackish bands," the dorsum of the main portion of the thorax (scutum) is actually unicolorous, with scarcely a trace of longitudinal stripes, but spotted as in *P. batesi* Austen, that is to say, with a pair of small, blackish-brown, admedian spots on the transverse suture, a large seal-brown blotch in front of the scutellum, and the postalar calli similarly marked; the humeral calli are pale drab-grey pollinose above. The dorsum of the main portion of the thorax being dark brown, with a thin, smoke-grey, faintly silvery, pollinose covering, clothed with fine, cinnamon-buff or drab-coloured hair, the general appearance of this part of the body resembles that of moleskin. The dorsum of the abdomen, which is unicolorous and, when viewed at an angle from behind, appears dull Mars-brown, has a bright silvery sheen when regarded from other directions.

Pantophthalmus argyropastus is one of the smaller representatives of its genus, the type, which is from Panama, measuring only 24·5 mm. in length.

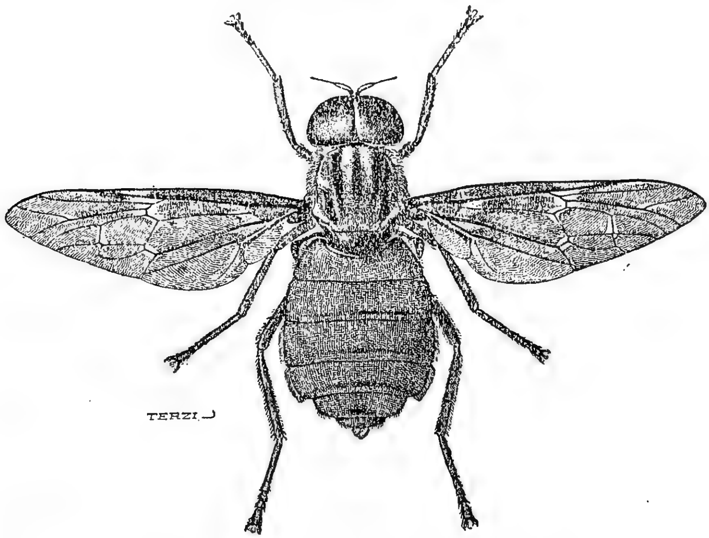
Pantophthalmus versicolor, sp. n. (Text-fig. 4.)

♂.—Length (three specimens) 27 to 30 mm.; width of head 7·75 to just over 8 mm.; greatest width of abdomen (across third tergite, exclusive of fringe of hair) 12·2 to 14·25 mm.; length of wing 22·25 to 24·6 mm.

Medium-sized species, with smallish head, which is distinctly flattened antero-posteriorly, striped thorax, and (at any rate in ♂) vivid ferruginous or orange-rufous, sharp-edged abdomen; facial tubercle or "beak" in ♂ either indistinguishable, its position marked by a pit, or minute and vestigial; abdominal tergites without lateral spots, though basal angles of first tergite extensively, and those of second tergite narrowly, mummy-brown; wing-markings in ♂ resembling those in same sex of P. tabaninus *Thunb.; hind femora of uniform thickness, without a spine on under surface, and with terminal spine represented only by a blunt projection.*

Head: face and jowls mummy-brown, a transverse, horizontal, smoke-grey, pollinose streak on front margin of jowls connecting each eye with buccal cavity; occiput greyish-olive, posterior orbits silvery-white pollinose; jowls clothed with mummy-brown hair, which is shining ferruginous at base; first and second segments of *palpi* clove-brown, clothed, like the terminal segment except distal extremity of latter, with brownish-ferruginous hair, terminal segment russet (brownish at base), cylindrical, straight, bluntly pointed at distal extremity; *antennæ* in ♂ lighter or darker cinnamon-brown (terminal style ochraceous-tawny), third (compound) segment viewed from side bluntly lanceolate in outline, second segment midway between base and distal extremity bearing a circlet of short, sparse, cinnamon-brown or ochraceous-tawny hairs. *Thorax*: ground-colour of dorsum of scutum mummy-brown or olive-brown; dorsum smoke-grey or pale smoke-grey pollinose in front, on humeral calli, lateral margins, lateral expansions of transverse suture, and on postalar calli; central region of dorsum bearing three conspicuous, dark, converging, longitudinal stripes (approximately equal in breadth, except that outer stripes are usually somewhat broader in front), extending from front to hind margin, but confluent posteriorly after passing transverse suture, outer stripes black or blackish-brown, median stripe paler, dark mummy-brown, sometimes less noticeable than outer stripes; behind transverse suture a short blackish-brown or dark brown longitudinal stripe on each side, extending from suture to postalar callus, and on inner side of this stripe a somewhat oblique, shining, chestnut-brown stripe; dorsum, except main portion of upper surface of scutellum, which is bare, thickly clothed with fine, silky, glistening, reddish-brown, ochraceous-tawny or tawny-olive hair, which on lateral borders is longer than elsewhere; scutellum mummy-brown, dark seal-brown, or russet-brown, more or less distinctly shimmering silvery-white

Text-figure 4.



Pantophthalmus versicolor Austen, ♂. × $1\frac{2}{3}$.

or shimmering smoke-grey pollinose above, except on hind border; pleuræ and pectus chocolate-brown or warm sepia-coloured, clothed with fine and fairly long, dark brown or reddish-brown hair. *Abdomen*: second and two following tergites each with a reddish-brown transverse band, just in front of hind margin and widely separated from lateral extremities in each case, posterior half of fifth tergite with an ill-defined blotch of similar colour in centre, not reaching hind margin; first tergite thinly clothed with fine hair, which is ochreous and recumbent except on basal angles where it is brownish and erect; second and three following tergites sparsely clothed with minute, appressed, glistening, ochraceous-tawny hairs, which in the case of second and third tergites at any rate are only noticeable on close scrutiny, sixth tergite clothed with longer hair of similar colour; lateral extremities of second tergite, except posterior angles, clothed with dark brown or brownish hair, those of third and fourth tergites fringed with longer, outstanding, closely set, shining, cinnamon-rufous or russet-tawny hair, lateral extremities of fifth tergite with a shorter, thinner, and paler fringe of similar character; first sternite mummy-brown or sepia-coloured (hind border smoke-grey or drab-grey pollinose), clothed with fine and fairly long, erect, dark brown hair; remaining sternites sepia-coloured, lateral extremities of third and following sternites paler (ochraceous-tawny); second and two following sternites (except lateral extremities of third and fourth), and central portion of fifth sternite thinly clothed with fine, dark brown hair, which on second sternite, at least anteriorly, is longer and erect, but elsewhere is shorter and appressed; sixth sternite, and lateral extremities of the two preceding sternites, clothed with russet-tawny hair; membrane connecting sternites with corresponding tergites longitudinally wrinkled, dark brown in case of first segment, and in case of succeeding segments dark brown in front and ochraceous-tawny behind. *Wings* sepia-coloured, with pale (cream-buff) markings as shown in text-fig. 4, these markings occupying corresponding positions to those in wing of *P. tabaninus* Thunb., but somewhat more restricted in extent; darkest areas in wing are those which are usual in this family, namely first costal cell and cell immediately below, second costal cell except its distal extremity, first basal cell except its base and tip, and a smaller and somewhat ill-defined area including stigmatic region, extending from costa to distal half or three-fourths of discal cell, with an outward extension along third longitudinal vein; veins for most part ferruginous or mummy-brown, paler in pale areas. *Squamæ* blackish-brown, fringed with similarly coloured hair, and also with a tuft of shining tawny or russet hair. *Halteres*: stalks ochraceous-buff or ochraceous-tawny, knobs mummy-brown. *Legs* uniformly russet or chestnut-brown, tarsi sometimes paler (cinnamon-rufous); legs clothed with glistening hair of similar colour, long and fine on front and hind femora short elsewhere, hair on femora sometimes appearing dark brown, sometimes tawny; claws orange-cinnamon or russet, their distal extremities black; pulvilli and empodia ochraceous-buff or orange-buff.

Guatemala and Mexico. Holotype, Pancina, Vera Paz, Guatemala (*G. C. Champion*); two paratypes, Cuesta de Misantla, Mexico (*M. Trujillo*). The holotype is the specimen briefly described, but not named, by Osten Sacken (Biol. Centr.-Amer., Dipt. i. p. 68).

Through the kindness of Mr. J. E. Collin, the British Museum (Natural History) has received a solitary ♂ of this species, which unfortunately is in poor condition and is without a locality label. In the Bigot collection, whence it was taken, this fly was associated with two ♂♂ of *P. tabaninus* Thunb. and all three specimens stood above the label "*Acanthomera seticornis* Wied. ♂," in Macquart's handwriting (*vide supra*, p. 563).

In the male sex, at any rate, *Pantophthalmus versicolor*, by means of the characters mentioned in the diagnosis printed in italics above, is readily distinguishable from any of its congeners at present known. From the male of *P. tabaninus* Thunb., for which at the first glance it might possibly be mistaken, the male of the present species can be distinguished at once owing to its smaller and differently shaped head, duskier and differently striped thorax, and broader and flatter, sharp-edged abdomen, the sides of which are devoid of white spots, and are not black on the basal half.

Pantophthalmus pictus Wied.

Acanthomera picta Wiedemann, Diptera Exotica, p. 61, Tab. ii. fig. 2 (1821).

Acanthomera flavipes Macquart, Mém. Soc. roy. des Sc., de l'Agric. et des Arts de Lille, Année 1846, p. 42, Tab. i. fig. 2 (1847). [New synonym.]

Acanthomera magnifica Walker, Ins. Saund., Diptera, Part i. p. 74, pl. 1. fig. 1 (1850). [New synonym.]

Acanthomera teretruncum Fiebrig, Zeitschr. f. wiss. Insektenbiol., Bd. ii. pp. 345–347, figs. 17–19 (1906).

Of this species, which is the genotype of *Acanthomera* Wied., the British Museum (Natural History) possesses a ♂ from an unknown locality in Brazil (purchased from — Argent, 1847); a ♀ (the holotype of *Acanthomera magnifica* Walk.), from "South America" (*ex coll.* W. W. Saunders); and a second ♀, taken at Sapucay, Paraguay, 21.i.1905 (*W. Foster*). The type of *Acanthomera magnifica* Walk. represents a form of the species in which the dorsum of the abdomen is for the most part ferruginous, tawny, or orange-cinnamon instead of black, the latter colour being confined to the base (first visible tergite, except its hind border), ovipositor, and a blotch at each lateral extremity of the second to the fourth tergites inclusive. In the case of the type of *A. magnifica*, moreover, the whitish transverse streak near each posterior angle of the third ventral scute is wanting, but this is doubtless due to individual variation.

From the Bigot collection, thanks to the generosity of Mr. J. E. Collin, the National series has been enriched by the type of *Acanthomera flavipes* Macq. (stated by Macquart—*loc. cit.*—to be from Brazil), and two other ♀♀, all of which unfortunately are without locality labels. In the case of Macquart's type the abdomen is russet-brown ("brun vineux," *apud* Macquart, *loc. cit.*), a fact which misled Enderlein (Zool. Anz., Bd. xli. p. 101 (1912)) into treating *A. flavipes* Macq. as specifically distinct from *A. picta* Wied. Enderlein, however (*t. cit.* p. 105), is perfectly correct in regarding *A. teretruncum* Fiebrig as a synonym of

A. picta Wied., and indeed, so long ago as 1908, the present writer placed a manuscript note in the Museum collection drawing attention to this identity.

The species under discussion is represented in the Hope Department of the Oxford University Museum by two ♀♀, one of which is of ordinary size (total length, including ovipositor and facial beak, 41·2 mm.; wing-expanse 73 mm.), while the other is a diminutive example, with dimensions (total length, including ovipositor and facial beak, 29 mm.; wing-expanse 50·5 mm.) much below normal. Both specimens are unfortunately without locality labels; the larger of the two is labelled "Miers coll.," while the other, probably collected by Bates on the Amazons, bears a label in Westwood's handwriting, with the words "E Mus. Saunders. 1867."

In the wing-marking of *Pantophthalmus pictus* a characteristic feature is a broad, dark brown, L-shaped blotch, the shorter arm of which meets the costa in such a way as to include the tip of the mediastinal vein, while the longer arm embraces the third longitudinal vein between the anterior transverse vein and the bifurcation of the former, without being in contact with either.

Fiebrig's interesting observations on the preliminary stages and bionomics of "*A. teretruncum*" have already been referred to (*vide supra*, p. 556).

Pantophthalmus chuni Enderl.

Acanthomera chuni Enderlein, Zool. Anz., Bd. xli. no. 3, pp. 102, 103, fig. 4 (December 20, 1912).

This fine species—described by its author from two ♀♀ from Peru, in the Zoological Museum, Stettin—is represented in the National Collection by a single ♀ from Brazil (R. Amazons—precise locality unknown: *H. W. Bates*), measuring 42 mm. in length from the tip of the prominent facial beak to the end of the ovipositor, and having a wing-expanse of 70·6 mm. On the second and third abdominal tergites, conspicuous against the velvety-black or sooty-black ground-colour, are half-a-dozen specimens of the Acarid parasite already noticed in connection with several other species.

By the courtesy of Dr. Hugh Scott, the writer has been permitted to examine a ♀ of this species in the University Museum of Zoology, Cambridge. Except that its dimensions (length from tip of facial beak to end of ovipositor 29 mm., wing-expanse 53·75 mm.) are much below normal, this example, which was likewise taken on the River Amazons (*Nevile Goodman*, 1879), agrees with that already mentioned.

In spite of certain apparent discrepancies, there can be no doubt as to the correctness of the identification of the Brazilian specimens referred to above. The description of *P.* (*Acanthomera*) *chuni* furnished by Enderlein is seriously misleading in more than one respect. In the first place the German author speaks of the face as being "very broad and very greatly widened in front"; a comparison, however, of the British Museum specimen with examples of other species shows that the ♀ of *P. chuni* is in no way abnormal in this respect. Secondly, both in the diagnostic table on p. 102 (*loc. cit.*) and in the detailed description on the following page, Enderlein speaks of a *single*, *relatively narrow* thoracic stripe. On the other hand, in actual fact, not only does the dorsum of the thorax exhibit the *three* dark thoracic stripes so constantly seen in representatives of the family Pantophthalmidæ, but, even regarding the thoracic markings as consisting of a single stripe, bearing on its surface a pair of paler, admedian stripes, the measurements given by Enderlein himself, which agree in detail with the corresponding measurements taken from the British Museum specimen, show that as a characterization "relatively narrow" is entirely unwarranted.

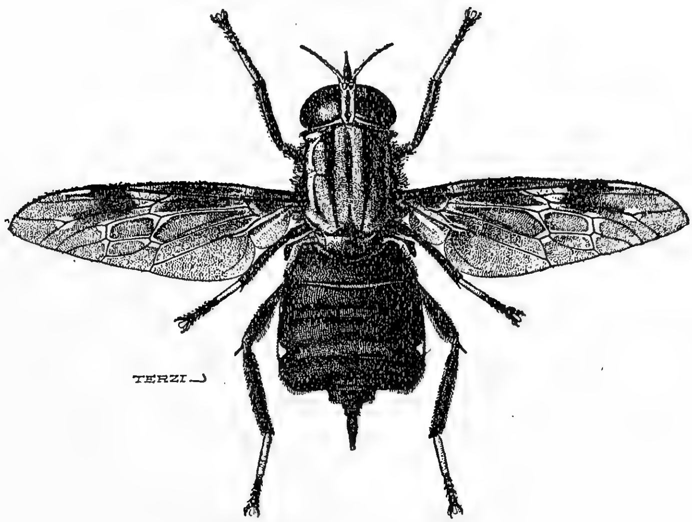
Pantophthalmus conspicabilis, sp. n. (Text-fig. 5.)

♀.—Length (one specimen), including ovipositor and facial beak, 42 mm.; width of head 10·5 mm.; width of front at vertex 1·8 mm. (immediately above base of antennæ just under 2 mm.); length of facial beak just under 3 mm.; greatest width of abdomen (across third tergite) just under 16 mm.; length of wing 31·5 mm.

In ♀ sex, at least as represented by typical specimen, a grey and black species, with prominent, sharp-pointed facial beak; almost parallel-sided front; conspicuously striped thorax; blunt-edged abdomen, which on dorsal surface, on each lateral border, bears two conspicuous silvery-white spots and a fringe of short hair; wings marbled with sepia and light buff, somewhat resembling those of Pantophthalmus (Acanthomera) chuni *Enderl., but differing in details of pattern; and with hind femora incrassate towards tips, and bearing a small spine on under surface and a large terminal spine.*

Head: face and jowls sepia-coloured or mummy-brown, inner margin of each eye bounding face with a narrow, smoke-grey, pollinose edging, which above sends off an extension to meet base of facial beak, while below a similar but silvery-grey extension connects pollinose edging of eye with buccal cavity; facial beak long and sharp-pointed, its expanded basal portion dark brown above, russet-brown on sides below, the shining tip blackish-brown; front (frons) of moderate width, and only very slightly broader at its anterior extremity than at vertex; front and occiput, including posterior orbits, uniformly olive-buff or pale olive-buff pollinose, except that the conspicuous ocellar tubercle, which is distinctly separated from vertical margin of occiput, is mummy-brown, and that in certain aspects, at least in typical specimen, behind ocellar tubercle, on vertical margin of occiput, and also on central anterior portion of front, above base of antennæ, ground-colour shows through pollinose covering, and appears more or less tawny or ochraceous-salmon-coloured; upper portion of occiput, except posterior orbits, clothed with fine, ochraceous-buff hair, basioccipital region and lower portion of occiput, except posterior orbits, clothed, like jowls, with fine, brownish or dark brown hair; first and second segments of *palpi* dull tawny-olive (second segment dark brown shortly before distal extremity), clothed on sides and below with blackish hair which is longer towards tip of second segment, distal segment russet-coloured with a thin greyish-pollinose covering, cylindrical and acuminate, considerably thicker than base of proximal segment, but less swollen than is typically the case in the genus *Rhaphiorhynchus*, distal segment at base and on outer surface bearing a few short black hairs; *antennæ* in ♀ 5·6 mm. in length in case of type, agreeing generally in shape, and in form and relative dimensions of the eight divisions of the third (compound) segment, with antenna of *Pantophthalmus* (*Acanthomera*) *chuni* Enderl., ♀, as figured (Zool. Anz., Bd. xli. no. 3, p. 104, fig. 4, December 20, 1912) by its author; first and second segments of antennæ mummy-brown, distal extremity of second segment sparsely fringed with short, ochreous hairs, proximal division of third segment mummy-brown, next six divisions tawny, terminal (elongate and attenuate) division paler (pinkish-cinnamon), entire antennæ, when viewed from certain angles, clothed with a thin, silvery-grey, pollinose covering. *Thorax*: dorsum of main portion (scutum) silvery-grey (a deep border on each side, extending from humeral to postalar calli inclusive, silvery), median area in front of transverse suture when viewed from certain angles tinged with pinkish-cinnamon (at least in case of type), owing to ground-colour showing through; from inner end of each humeral callus a conspicuous, blackish-brown longitudinal stripe extends backwards, each stripe being fairly broad in front and diminishing in width as it passes back, until at a point about one-third of the distance between transverse suture and prescutellar groove it becomes suddenly attenuate, and is thence continued as a narrow extension as far as the prescutellar groove, in front of which it is connected with its fellow; attenuate portion of blackish-brown longitudinal stripes scarcely noticeable from certain angles, and completely visible only when insect is viewed at a low angle from behind; in middle line, between the two blackish-brown stripes, is an incomplete, paler (brownish-drab) longitudinal stripe, which, commencing as a deltoid expansion resting upon posterior commissure between the attenuate ends of the blackish-brown stripes, extends forwards, disappearing (in case of type, at least) before reaching transverse suture, but reappearing on level of latter, and tapering to a point and terminating between humeral calli; on upper margin of lateral silvery border on each side, between inner extremities of humeral and postalar calli, is a narrow, longitudinal brownish streak, which, following configuration of thorax, curves outwards in front of transverse suture, and makes a similar but rather flatter curve behind it; scutellum mummy-brown (posterior border, which is thickly covered with small, polished, rounded tubercles, mainly blackish-brown), lateral extremities of dorsal surface silvery-grey; dorsum of scutum clothed with fine, short, silky, yellowish or brownish hair, which becomes longer on hind border; scutellum, except anterior half of dorsal surface, which is bare, clothed with short, dark brown or blackish-brown hair; pleuræ and pectus mummy-brown (appearing darker when viewed from certain angles), clothed with fine, dark brown hair. *Abdomen* (at least in case of type, and except as regards the lateral silvery-white spots) uniformly blackish-brown or brownish-black above and below (ventral surface perhaps rather more brownish than dorsal); second and

Text-figure 5.



Pantophthalmus conspicabilis Austen, ♀. $\times 1\frac{1}{5}$.

third tergites each with a conspicuous, silvery-white spot on each side, close to posterior angle; lateral borders of dorsum clothed with blackish-brown hair, which on second and two following tergites forms a not very conspicuous fringe on each side (on lateral margins of fourth tergite the fringe is longer and sparser than on the two preceding tergites); first sternite, and central area of second, clothed with fine, dark brownish hair. *Wings* marked as shown in text-fig. 5, the dark blotches on costal border sharply defined and conspicuous; veins sepia-coloured or cinnamon-brown, in pale areas usually paler (pinkish-cinnamon). *Halteres*: stalks cinnamon-brown, knobs blackish-brown. *Legs*: front femora with a small but distinct terminal spine, which on middle femora is represented by a blunt triangular projection; hind legs with a very small, somewhat blunt and triangular, subfemoral spine; terminal spine on hind femora large, long (1 mm. in length) and sharp; length of hind femur (exclusive of terminal spine) 15·6 mm.; hind femora distinctly thickened towards distal extremity, clothed with fine, short, blackish hair, which is longer on flexor surface and, owing to greater density, especially noticeable between subfemoral spine and tip, distal extremities of extensor and posterior surfaces clothed mainly with bright, appressed, russet-coloured hair; hind tibiæ thickly clothed with fine, black hair, longer than elsewhere on extensor surface, where it forms a conspicuous fringe; femora reddish-brown, darker towards distal extremities, tips of hind pair reddish-brown; front tibiæ russet-coloured, clothed on flexor surface with short, glistening, ochraceous-tawny hair; middle tibiæ russet-brown, clothed for most part with dark brown hairs; hind tibiæ black; first segment of tarsi buff-yellow, extreme tip brown; remaining segments of front tarsi sepia-coloured, second segment, except distal third, and extreme bases of following segments cinnamon-buff, last three segments of front tarsi clothed above with dark brown hairs, tip of last segment and distal angles of preceding segments clothed with bright ochraceous-tawny hairs; second segment of middle tarsi cinnamon-brown, darker at distal extremity, last three segments of middle tarsi dark brown, clothed above with similarly coloured hair, tip of last segment clothed with tawny hair; last four segments of hind tarsi blackish-brown, second segment paler at base; claws orange-cinnamon or russet, their tips black; pulvilli and empodia ochraceous-tawny.

Colombia (— *Chevrolat*): *ex coll.* W. W. Saunders.

In the ♀ sex, at any rate, the handsome species described above, although at the first glance presenting a certain superficial resemblance to *Pantophthalmus* (*Acanthomera*) *chuni* Enderl. (*vide supra*), is distinguishable *inter alia* owing to the pallor of the front (frons) and of the dorsum of the thorax; the reduction in the striping of the latter as regards the median longitudinal stripe and the distal extremities of the paired dark stripes; and the shorter, much more densely hairy and consequently apparently stouter hind tibiæ. In the case of the type, at least, of *P. conspicabilis*, as compared with the specimen of *P. chuni* referred to on p. 576, the lateral silvery-white spots on the dorsum of the abdomen are blunter and rounder.

This species is in any case closely allied to, and may ultimately prove to be identical with, *Pantophthalmus kertészianus* (*Acanthomera kertésziana*) Enderlein, described (Zool. Anz., Bd. xliv. no. 13, p. 578, July 28, 1914) from two ♀ ♀ from Peru, in the Museums of Budapest and Stettin. Since, however, Enderlein (*t. cit.* p. 579), in describing the wing in *P. kertészianus*, says that the "basal *fourth* and a large spot on the anterior margin" are "pale ochreous," it seems wiser, provisionally at any rate, to regard *P. conspicabilis* as distinct.

Pantophthalmus conspicuus, sp. n. (Text-figs. 6, 7.)

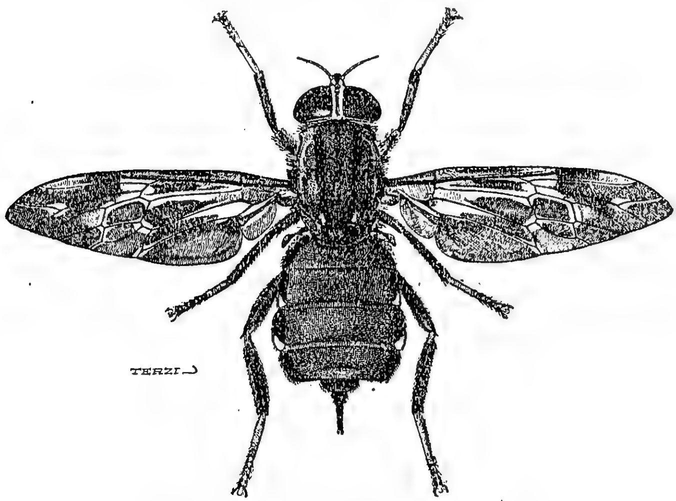
♀.—Length (one specimen), including ovipositor and facial beak, 36·2 mm.; width of head 9·4 mm.; width of front at vertex 1·8 mm.; greatest width of abdomen (across third tergite) 14·5 mm.; length of wing 28 mm.

In ♀ sex, at least in case of typical specimen, a grey, honey-yellow or isabella-coloured (probably in life green) and black species, with facial beak represented by a blunt, rounded prominence, conspicuously black-striped thorax, blunt-edged abdomen, and no subfemoral spine on hind legs; lateral borders of first four abdominal tergites black, with two large, silvery-white spots on each side; wings marked as shown in text-fig. 6, *broadly cream-buff or buff-yellow at base; hind femora somewhat incrassate towards tips, hind tibiæ thickly clothed with black hair, appearing stout.*

Head: front (frons) light greyish-olive pollinose, of moderate and uniform width, ocellar tubercle black; face and jowls mummy-brown, tip of bluntly rounded facial beak reddish, inner and lower orbits bordering face and jowls narrowly olive-buff pollinose, jowls and basioccipital region clothed with dark brown or blackish-brown hair; occiput dark olive-buff pollinose, appearing buffy-brown in certain areas and mummy-brown below vertex, clothed with fine, brownish hair, which has an ochraceous-tawny or cinnamon-brown sheen, posterior orbits light buff pollinose, bare; first and second segments of *palpi* sepia-coloured, together shorter than distal segment and clothed with dark brown or blackish-brown hair, distal segment russet-coloured, cylindrical, tapering somewhat towards tip and ending bluntly, with a few blackish hairs on inner side towards base; *antennæ* thinly olive-buff or smoke-grey pollinose, first and second segments tawny, distal extremity of second segment fringed with bright ochraceous-tawny hairs, third (compound) segment russet-brown, terminal division paler (cinnamon- or pinkish-cinnamon-coloured). *Thorax*: dorsum of main portion (scutum) pale smoke-grey pollinose (ground-colour largely chestnut-brown or russet, ground-colour of humeral calli pinkish-buff), with two straight and complete, converging, longitudinal black stripes of uniform width, which in front are in contact with inner ends of humeral calli, and posteriorly meet together in prescutellar groove; in middle line a brownish, dusky stripe (visible at least when insect is regarded at an angle of 45° from behind), commencing on front margin as an elongate black spot, extends backwards and becomes indistinct shortly after passing level of transverse suture; scutellum, except lateral extremities, which are whitish-grey pollinose and clothed with pale hair, blackish-brown, clothed above with short blackish hair, and below with brownish hair: dorsum of scutum clothed in front with short yellowish hair, and posteriorly with short blackish or black hair, on each side above pleuræ and in front of transverse suture an area of longer, dark brown or brownish hair, posteriorly ochraceous-tawny at base;

pleuræ and upper border of pectus black, clothed with black or blackish hair, central area of pectus light greyish-olive pollinose (ground-colour chestnut-brown), clothed with fine, cinnamon-buff-coloured hair. *Abdomen*; first four tergites, at least in case of type, honey-yellow or isabella-coloured, here and there irregularly mottled with dark green or greyish-olive, their lateral extremities black, fifth tergite dark olive, rather less than posterior half of preceding tergite similarly coloured in centre, second and third tergites each with a large, bluntly triangular, silvery-white spot in each posterior angle, not quite reaching hind margin in either case, first tergite with a pair of very small whitish spots in corresponding position but further from hind margin, ovipositor black or blackish-brown (distal extremity cinnamon-coloured);

Text-figure 6.



Pantophthalmus conspicuus Austen, ♀. × $1\frac{1}{5}$.

lateral borders of first four tergites, except silvery-white spots, clothed with fine, short, black hair, which, though longer on outer edges, does not form a conspicuous fringe; first four tergites, except lateral extremities, sparsely clothed with short, or minute and inconspicuous, ochraceous-buff or ochraceous-orange hairs; first four sternites clove-brown (their lateral extremities blackish-brown), with a shimmering, smoke-grey, pollinose covering and sparsely clothed with short, ochraceous-orange hairs, ventral surface of projecting lateral extremities of first four tergites black, fifth sternite blackish-brown, sparsely clothed with similarly coloured hair, coloration of ventral surface of ovipositor same as that of dorsal. *Wings*: infuscated (blackish-brown) area chiefly confined to distal third and posterior two-thirds, but first basal cell with an elongate dusky blotch occupying part of its distal two-thirds, but not extending either to tip or to hind border of the cell, an elongate brownish streak in second costal cell above foregoing blotch, a large pale spot on fork of third longitudinal vein, and a more or less distinct pale streak along costa at tip of marginal cell; infuscated area in discal cell not in contact with boundaries of cell at any point except on anterior basal transverse vein, across centre of which it is connected with large infuscated area in second basal cell, which again is continuous with infuscated axillary cell and alula, through infuscation occupying greater part of anal cell; veins mummy-brown or cinnamon-brown. *Halteres*: stalks tawny-olive, knobs dusky dull green or dusky olive-green. *Legs*: coxæ and trochanters tawny or russet-coloured, clothed mainly with tawny or ochreous hairs, front coxæ on outer side blackish and clothed with similarly coloured hair; front and middle femora with a bluntly triangular projection at distal extremity, terminal spine on hind femora not unusually large; front and middle femora chestnut-brown, with an ill-defined dark brown band before distal extremity, hind femora similarly coloured but darker, femora clothed mainly with dark brown or blackish hair, front and middle femora sparsely clothed at base on under side with short tawny hair, tips of all femora, at least above, and base of hind femora, clothed with glistening cinnamon-rufous hair, particularly noticeable at tips of hind femora on extensor surface, where it is short and closely appressed; front tibiæ russet, clothed largely with short, glistening tawny or cinnamon-rufous hairs, with longer and sparser dark brown hairs on extensor surface, middle tibiæ chestnut-brown (darker on anterior surface), extensor surface sparsely clothed with dark brown hair, flexor surface and tips, which are paler, clothed with short, glistening, appressed, cinnamon-rufous hair; hind tibiæ black (extreme tips paler and clothed with ochraceous-tawny hair); first three segments of front and middle tarsi, except tips, ochraceous-buff, last two segments and tips of preceding segments cinnamon-brown; front and middle tarsi entirely clothed with glistening, appressed, ochraceous-tawny hairs, longer at distal extremity of upper surface of terminal segment, minute or short elsewhere; first segment of hind tarsi warm buff or cinnamon-buff (extreme tip faintly cinnamon-brown), clothed with short, glistening, appressed, cream-buff hair; last four segments of hind tarsi cinnamon-brown, clothed (as also extreme tip of first segment) with glistening, appressed, ochraceous-tawny hairs; claws tawny or russet-coloured, their tips black; pulvilli and empodia ochraceous-tawny.

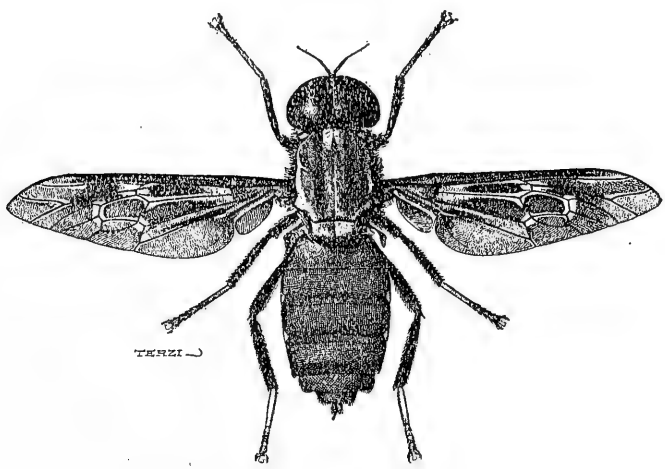
British Honduras: Corozal, 26. ix. 1922, "came to light, at night" (*Dr. F. L. Davis*). The collector of the type, who has been kind enough to present the specimen to the National Collection, writes that, although resident in British Honduras for very many years, he cannot remember having met with this species previously.

Apart from the coloration of the abdomen, as exhibited in the case of the typical specimen at least, *Pantophthalmus conspicuus* in the ♀ sex exhibits a certain superficial resemblance both to *P. chuni* Enderl. and *P. conspicabilis* Austen. From both of these species it is, however, distinguishable *inter alia* owing to the wings being broadly pale (cream-buff or buff-yellow) at the base, and to the facial beak being bluntly rounded at the tip instead of acuminate. From *P. chuni*, apart from any other characters, it is further distinguished by its stout, furry hind tibiæ, and pale front (frons).

The type of *P. conspicuus* was originally preserved and sent to the Museum in spirit, and there is reason to believe that, owing either to this, or to natural *post-mortem* changes, the coloration of the disc of the abdomen (exclusive of the lateral borders) has suffered alteration, and that it was originally *green*. This at any rate seems a natural deduction from the fact that traces of green are visible here and there in the first four abdominal tergites, and that the halteres are still more or less green (*vide* description above). In any case, this is not the only instance in which a representative of this family is more or less green in life, since, according to the late Prof. Hermann (Deutsch. Ent. Z., Jahrg. 1916, Heft i. pp. 43, 45, April 1, 1916), the Brazilian *Pantophthalmus alienus* Herm., in the female sex at any rate, in which the ground-colour of the abdomen is dull velvety-black, has the hind margins of the first four tergites apple-green, while there are indications that in life the scutellum and halteres are of the same colour. It is of course well known that in those instances among Diptera—highly exceptional if the Chironomidæ be excluded—in which the predominant colour in life is green, the green pigment after death is often or usually, largely or entirely, replaced by yellow. As cases in point, it will suffice to mention *Oxycera trilineata* Fabr., and other Stratiomyidæ, such as the South American *Odontomyia pulchra* Wied.; *Tabanus fasciatus* Fabr., of West and Central Africa; and the European *Didea alneti* Fln.

What is almost certainly the male sex of *P. conspicuus* is represented by a solitary ♂ (*cf.* text-fig. 7) from the R. Amazons, Brazil (*H. W. Bates*), in the Hope Department, University Museum, Oxford (*ex coll.* W. W. Saunders). The dimensions of this specimen are as follows:—Length 29·6 mm.; width of head just over 8 mm.; greatest width of abdomen (across hind margin of second tergite) 9·4 mm.; length of wing 24·4 mm. Viewed from above and slightly from in front, the dorsum of the thorax, except the hind border of the scutellum, is unstriped and uniformly silvery, forming a striking colour-contrast with the dorsum of the abdomen, which is ochraceous-tawny; the lateral extremities of the first four abdominal tergites are black and deflexed, while the posterior angles of the second and third tergites are each occupied by a large, bluntly triangular, silvery-white spot, lateral borders and spots being scarcely noticeable from above. The other principal external characters are as follows:—*Head*: frontal and vertical triangles smoke-grey pollinose, ocellar tubercle dark brown; face and jowls sepia-coloured, jowls clothed with hair of similar hue, inner orbits bordering face narrowly pinkish-buff pollinose; facial beak represented by a low, elongate oval, tawny-brown area, which is scarcely noticeable; occiput shimmering golden-ochraceous-buff pollinose, with darker reflections, and clothed with fine yellowish hair; *palpi* similar in colour to those of ♀, but distal segment considerably (about one-third) shorter than second; *antennæ* sepia-coloured, style paler, third (compound) segment cuneate, flattened from side to side, and deepest (in a dorso-ventral direction) at about one-fourth of its length from the base. *Thorax*: rather less than

Text-figure 7.



Presumptive ♂ of *Pantophthalmus conspicuus* Austen. × 1½. (From a specimen in the Hope Department, University Museum, Oxford).

posterior half of scutellum blackish-brown, clothed with brownish hair, dividing line between infuscated and silvery areas straight; dorsum of scutum, except lateral borders immediately above pleuræ, clothed with fine, short, reflexed, whitish hair, lateral borders clothed with longer hair, light ochraceous buff in front of, and yellowish behind transverse suture, under side of postalar calli blackish-brown; viewed at a slight angle from behind, dorsum of scutum shows unpigmented longitudinal stripes, corresponding to the paired black stripes and commencement of a median stripe exhibited by the ♀; pleuræ and lateral borders of pectus dark clove-brown or blackish-brown, clothed with similarly coloured hair, remainder of pectus light ochraceous-buff, clothed with fine, silky hair of similar colour. *Abdomen*:

venter ochraceous-buff, pinkish-buff pollinose, sparsely clothed with fine, glistening ochreous hairs, lateral extremities of sternites brownish; dorsum, except lateral borders of first four segments, clothed with ochreous or ochraceous-buff hairs, for most part minute and inconspicuous except on first and sixth segments, lateral borders of first four tergites, except silvery-white spots, clothed with black or blackish hair. *Wings* (*cp.* text-figs. 6 & 7) with markings corresponding extremely closely to those exhibited by ♀, but tips paler. *Halteres* cinnamon-buff. *Legs* agreeing in all essential respects with those of ♀; coloration of hind coxæ and their hairy covering as in case of adjacent area of pectus.

Pantophthalmus vittatus Wied.

Acanthomera vittata Wiedemann, Auss. zweifl. Ins. i. p. 109 (1828).

Acanthomera fulvida Bigot, Ann. Soc. Ent. Fr., 5e Sér., T. x., Bulletin, p. v (1880). [New synonym.]

A note in the National Collection in the handwriting of the late Baron C. R. Osten Sacken, and bearing the initials "O. S.," confirms the correctness of the identification of *P. vittatus* (*Acanthomera vittata*) Wied. as given above.

The following are the specimens of this species in the British Museum: a ♂, from the R. Amazons, Brazil (*H. W. Bates*); a ♀, also from Brazil, but exact provenance unknown, taken prior to 1849 (*Mrs. Noel*); and two ♀♀ (the type and paratype of *Acanthomera fulvida* Big.), from Guiana (*ex coll.* J. Bigot: presented by J. E. Collin, F.E.S.).

The two latter examples represent a form of *P. vittatus* in which the dark lateral spots on the dorsum of the abdomen are equally well developed in both sexes. Bigot himself (*loc. cit.*) mentions only a single specimen, but, since the alternative measurements given by this author agree with the respective lengths of the ♀♀ referred to, his remark "*Specimen unicum*" is probably a *lapsus calami*.

There are six specimens of *P. vittatus*—all ♀♀—in the Hope Department of the University Museum, Oxford. Of these, three are simply labelled "Miers coll.", and bear no further indication of provenance; of the remainder, one has a label with the words "S. S. Saunders, Bahia, Bz."; another is labelled "E Mus. Saunders, 1867"; and a label attached to the sixth example shows that this specimen was taken in Brazil, and purchased from Higgins in 1871. Considerable variation in size is noticeable in the Oxford series; while the dimensions of the largest ♀ (total length, including ovipositor and short facial beak, 32·25 mm.; wing-expanse 57 mm.) are approximately the same as those of Mrs. Noel's specimen in the National Collection, the corresponding measurements of the smallest example in the possession of the Hope Department are 24·6 mm. and 40 mm. respectively—practically the same as those of the smaller of the two ♀♀ from the Bigot collection, presented to the British Museum by Mr. Collin.

The ♂ and ♀ in the British Museum, collected respectively by H. W. Bates and Mrs. Noel, are each pseudo-parasitized by nymphs of the usual species of Gamasid mite. In the case of the ♂, there is only a single Acarid, which is on the upper surface of the abdomen; the pseudo-parasites on the ♀ are present on both sides of the abdomen, and, although only in small numbers, are more plentiful above than below. One of the specimens in the Oxford collection is similarly infested.

Pantophthalmus bellardii Bell.

Acanthomera bellardii Bellardi, Saggio di Ditterol. Messicana, Appendice, p. 16, Tav. iii. fig. 11 (1862).

Acanthomera championi Osten Sacken, Biol. Centr.-Amer., Diptera, vol. i. p. 67, Tab. iii. fig. 16 (1886). [New synonym.]

Pantophthalmus helleri Enderlein, Zool. Anz., Bd. xli. no. 3, pp. 108, 110, figs. 8, 9 (Dec. 20, 1912).

Although nothing can be said with reference to the male of *P. bellardii*, since it is at present unknown, in the female sex, as shown by the extensive series of specimens available to the writer for comparison, the species is normally one of the finest of its family, and is conspicuous, even among the huge Diptera with which this paper is concerned, as much on account of the dark coloration of the body and wings, as by reason of the shape of its shining abdomen. While females of *P. bellardii* of ordinary size are certainly not larger—perhaps if anything actually less bulky—than corresponding examples of *P. tabaninus* Thunb., the great breadth often exhibited by the flat abdomen, combined with the shining black surface of the first four abdominal tergites (except the base, hind border and lateral extremities of the first, and the hind borders and lateral extremities of the remainder), serves to make the present species noticeable among its congeners, among which, in actual size of the largest examples, females of *P. tabaninus* are its only rivals. It is therefore not a little curious, as well as unfortunate, that the holotype of *P. bellardii* —formerly in the Bigot collection, and generously presented to the British Museum (Natural History) by Mr. J. E. Collin, F.E.S.—is one of the smallest Pantophthalmids yet seen. The dimensions of a large female of *P. bellardii* in the National Collection are as follows:—Total length (ovipositor and short, blunt, facial beak included) 53·5 mm.; greatest breadth (measured across the third abdominal segment) 20·5 mm.; wing-expanse 86 mm. (nearly $3\frac{1}{2}$ inches). The corresponding measurements in the case of the type are respectively 24, 9·5, and 43 mm. Moreover, apart from its diminutive proportions, the type of *P. bellardii* is anything but *typical*, since it is faded, rubbed, and somewhat shrunken, having in all probability originally been preserved in spirit before being pinned. Nevertheless, the specific identity of Bellardi's type with even the largest member of the series of specimens under discussion is beyond question, and the examination of a small female of *P. bellardii*, which has been in the National Collection for upwards of fifty-five years, entirely supports this conclusion. In the latter specimen, as in the type, the shining transverse bands on the dorsum of the abdomen are russet-brown instead of black, and a similar coloration is exhibited by one or more of the larger females of *P. bellardii* in the British Museum.

The particulars with reference to the fifteen specimens of this species (including the type and paratypes of *Acanthomera championi* O. Sack.) in the National Collection are as follows:— One ♀ (holotype of the species), Mexico (— *Sallé*), *ex coll.* Bigot, presented by J. E. Collin, F.E.S.; one ♀ (type of *Acanthomera championi* O. Sack.), Chontales, Nicaragua (*E. M. Janson*); one ♀, Orizaba, Mexico (— *Sallé*); one ♀, Bugaba, Panama (*G. C. Champion*); one ♀, R. Dagua, Colombia (*W. F. H. Rosenberg*); one ♀, provenance unknown (*ex coll.* W. W. Saunders). The remaining nine specimens, presented to the British Museum (Natural History) by Mr. J. E. Collin, F.E.S., previously formed part of the collection of the late J. M. F. Bigot, where they were placed above the label "*A. heydeni*, Wied."* Of these examples, one is from Mexico, two are from Nicaragua, and the remainder (if the general label can be trusted) from Brazil.

Of the two females of *P. bellardii* belonging to the Hope Department, University Museum, Oxford, one is from Chontales, Nicaragua, 1870 (*E. M. Janson*), the other from Peru ("E Mus. Saunders, 1867").

From what has been stated above, it will have been seen that *P. bellardii*, at any rate in the female sex, is, like other species of Pantophthalmidæ, subject to great variation in size.

Infestation by Gamasid nymphs of the usual species is exhibited by at least two of the specimens in the National Collection; in the cases referred to, the pseudo-parasites in small numbers are clustered together beneath the hind margins of one or more of the distal abdominal tergites, commencing with the fourth. An Acarid pseudo-parasite of a different kind, determined by Mr. A. S. Hirst as an adult female of a species of *Macrocheles*, was found on the front (frons) of one of the Brazilian females from the Bigot collection.

According to Enderlein (Zool. Anz., Bd. xliv. no. 13, p. 585, July 28, 1914), *P. helleri* Enderl. is a synonym of *P.* (*Acanthomera*) *championi* O. Sack. It would be impossible to arrive at such a conclusion from a perusal of Enderlein's original description of *P. helleri* (*vide supra*), in which the front (frons) in the female is explicitly stated to be narrowed posteriorly, and to be less than twice as long as broad.

* *Acanthomera heydenii* Wied., though treated as a valid species by Enderlein (Zool. Anz., Bd. xli. p. 102 (1912)), is in reality synonymous with *Pantophthalmus tabaninus* Thunb. (*cf.* p. 562).

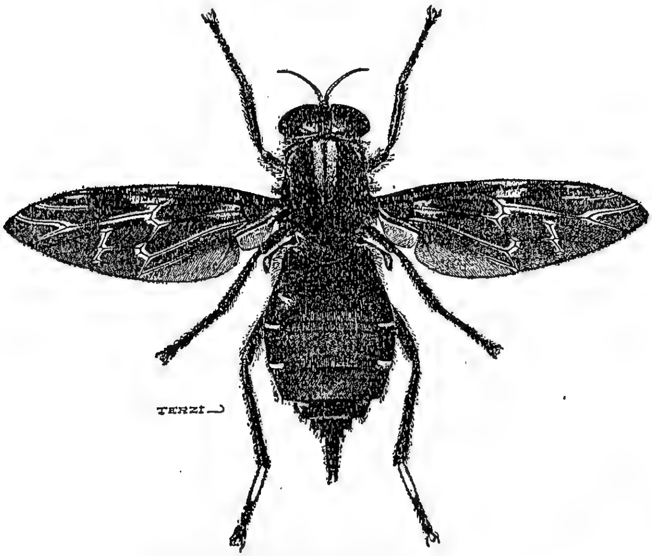
Pantophthalmus splendidus, sp. n. (Text-fig. 8.)

♀.—Length (one specimen), including ovipositor and facial beak, 37·0 mm.; width of head 8·4 mm.; width of front at vertex 1·25 mm.; greatest width of abdomen (across base of third tergite) 12·6 mm.; length of wing 28 mm.; wing-expanse 64·65 mm.

In ♀ sex, at least as represented by type, handsome, blackish-brown, black and orange-rufous species, with small, inconspicuous and only moderately sharply pointed facial beak; dorsum of thorax bearing a pair of admedian, sharply defined and conspicuous, pale olive-buff pollinose, longitudinal stripes, apparent colour of which is, in certain aspects, somewhat altered by hairy covering; blunt-edged abdomen, in which anterior portion of both second and third tergites is shining, and dorsum of which is black at base, then largely orange-rufous, with a black border on each side, in which are a small white spot, and two short, transverse, silvery-white streaks; dusky wings, with sharply defined, cinnamon-buff markings, as shown in text-fig. 8*; hind femora and tibiæ not so thickly clothed with hair as to appear furry, hind femora fairly stout, somewhat, though not very noticeably, incrassate towards tips, and with small subfemoral and terminal spines.*

Head: front (frons), jowls and basioccipital region black or blackish-brown, face mummy-brown, inner orbits bordering face and at least upper portion of front more or less buffy-brown or sepia-coloured; front of moderate width, somewhat broader at anterior extremity than at vertex; ocelli, at least in type, orange-cinnamon; facial beak shining black, its base enveloped above with a narrow, matt, mummy-brown covering; jowls and basi-occipital region clothed with fine, blackish-brown or dark mummy-brown hair; occiput smoke-grey pollinose, posterior orbits narrowly pale smoke-grey; *palpi* black or blackish-brown, distal segment somewhat swollen, pointed at tip, distinctly shorter than remaining portion of palpi, which is clothed with blackish hair, distal segment clothed with similar hair at base, and bearing two or three hairs of same kind at tip; *antennæ* slender (*i. e.* depth of third (compound) segment not greatly increased at base), blackish-brown or black, paler towards distal extremity, terminal division of third segment greyish cinnamon-coloured at tip, first and second segments somewhat sparsely clothed with black hairs. *Thorax*: dorsum, so far as can be seen, with no trace of small or minute, shining, rounded, wart-like tubercles, with which as a rule in Pantophthalmidae this region is characteristically and plentifully besprinkled; scutellum, sides of main portion of dorsum (scutum) behind humeral calli, and central area of dorsum in front of prescutellar groove and behind ends of olive-buff pollinose stripes chestnut-brown, this hue being darker on sides of scutum and brighter in case of scutellum; admedian, olive-buff pollinose stripes separated in middle line by a narrow, tapering, chocolate-brown stripe, and bordered on each side by a much broader, blackish or blackish-brown longitudinal stripe, which, commencing on front border and occupying entire space between humeral callus and corresponding admedian stripe, is continued backwards to prescutellar groove, becoming constantly narrower as it passes backwards, and in particular diminishing markedly in width after passing beyond end of olive-buff stripe, which itself disappears shortly after crossing transverse suture; behind latter, bordering each blackish or blackish-brown stripe on outer side, is a fairly broad, curved, shining stripe; humeral calli light ochraceous-buff in front, blackish-brown behind, outer extremity in each case shining, pointed, and reddish-brown; olive-buff pollinose stripes clothed with fine, ochraceous-tawny hair, remainder of dorsum of

Text-figure 8.



Pantophthalmus splendidus Austen, ♀. × $1\frac{1}{3}$.

scutum covered with fine russet-brown or russet-coloured hair, lateral borders of scutum in front of transverse suture clothed with dark brown hair, scutellum and oblong median area immediately in front of it clothed with bright russet-coloured hair; pleuræ and pectus mummy-brown, clothed with similarly coloured hair, rounded knob below base of wing on each side shining blackish-brown. *Abdomen*: first tergite black, clothed with fine black or blackish hair, and having on each lateral edge, a short distance in front of posterior angle, a small white spot; second and two following tergites orange-rufous (shining anterior border of second tergite mainly reddish-brown, at least in case of type), lateral borders black, shading off somewhat into brown on inner margin, a short, transverse, silvery-white streak just in front of each posterior angle of second and third tergites; apart from silvery-white streaks just mentioned, on both second and third tergites non-shining area is confined to posterior half of segment, is of less depth than shining area in front of it, and has its extremities, which are far from reaching lateral margins, tapered and rounded off; fifth tergite black, moderately shining and narrowly margined (incompletely so in front) with orange-rufous; remaining tergites blackish-brown or dark brown (terminal lobes or valves ochraceous-buff, sparsely clothed with ochraceous-tawny hairs); orange-rufous area of dorsum, as also fifth tergite, thinly clothed with glistening, decumbent, ochraceous-tawny hair, shining anterior border of second tergite clothed with similar hair, second and following tergites otherwise for most part thinly clothed with black hair; venter black (second and two or three following sternites shining), thinly clothed with black hairs. *Wings* (apart from cinnamon-buff markings) mummy-brown over rather less than proximal three-fourths of costal border, then lighter or darker sepia-coloured, typical specimen at any rate with a distinctly paler area in centre of certain cells, such as discal and second posterior; cinnamon-buff markings more sharply defined and more restricted than in case of several other species of *Pantophthalmus* already described, chief markings being at base of basal cells (whence extensions are emitted, to costa on humeral transverse vein, and along fifth longitudinal vein), between costa and proximal extremity of discal cell (including anterior transverse vein and an extension thence for some distance along third longitudinal vein), and streaks embracing respectively distal extremity of second, and anterior branch of third longitudinal veins, and distal boundaries of second basal and discal cells; costa clove-brown at base, otherwise mainly cinnamon-brown, veins elsewhere mummy-brown in darker, ochraceous-tawny in lighter areas. *Halteres*: (in dried condition, at any rate) stalks mummy-brown, knobs buff-yellow. *Legs*, except first segment of hind tarsi, uniformly black and clothed with black hair; first segment of hind tarsi light orange-yellow, clothed with short, ochraceous-orange hairs, tip of segment blackish-brown or black, clothed with similarly coloured hairs, extreme base of segment also blackish-brown; claws black; pulvilli and empodia ochraceous-buff.

Panama: Chiriqui Volcano, between 5000 and 9000 ft., 1915 (*H. J. Watson*).

Owing to its distinctive coloration and markings, *Pantophthalmus splendidus*—in the ♀ sex at any rate—cannot be confused with any of its congeners already known.

The specimen from which the above description has been drawn up bears, on the fifth and following abdominal segments, a small number of nymphs of the species of Gamasid mite (genus *Trachytes*) that has been mentioned so often in the course of this paper as occurring on various species of Pantophthalmidæ. In addition to these pseudo-parasites, a few other nymphal mites, apparently conspecific with the foregoing, were found on the left side of the thorax, among the hair on the anterior border of the mesopleura.

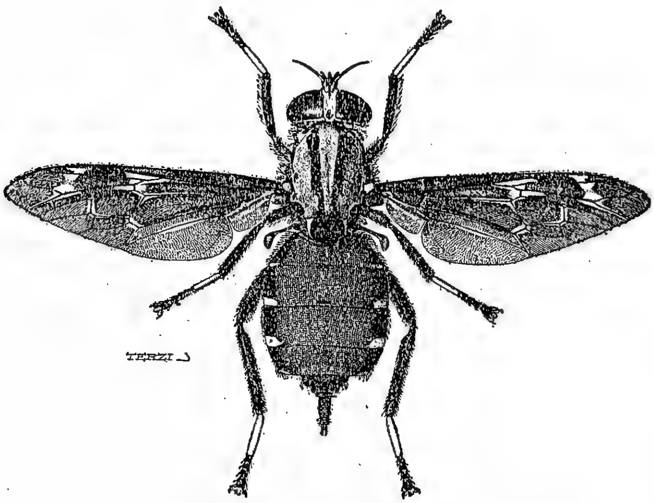
Pantophthalmus variegatus, sp. n. (Text-fig. 9.)

♀.—Length (four specimens), including ovipositor and facial beak, 29·5 to 36·25 mm.; width of head 7·5 to 9·2 mm.; width of front at vertex 1·4 to 1·5 mm.; greatest width of abdomen (across hind border of second tergite) 9·8 to 13·0 mm.; length of wing 25·0 to 28·5 mm.

Strongly marked species, with, in ♀ sex at any rate, dorsum of thorax vinaceous-buff, conspicuously striped and spotted with black or blackish-brown, and with dorsum of abdomen ochraceous-orange or orange-rufous, with sharply defined black lateral borders, in each of which are four transversely elongate, silvery-white spots, the fourth pair of spots less conspicuous than the others and sometimes indistinct; facial beak prominent but not sharp pointed; wings strongly infuscated, mummy-brown at base, then sepia-coloured or fuscous, with ochraceous-buff or cream-buff markings as shown in text-fig. 9; *hind femora incrassate towards tips, with very small terminal spine, subfemoral spine likewise small, difficult to distinguish among the hair.*

Head: front (frons) warm buff, of moderate and uniform width; in middle line, just above bases of antennæ, a narrow, short, somewhat sagittate, brownish streak; ocellar tubercle black, bluntly ovate, sharply defined and conspicuous; face dark seal-brown (facial orbits narrowly olive-buff), below facial beak with an ochraceous-orange transverse band, extremities of which turn upwards on each side of base of beak, a similar but paler (light ochraceous-buff) band, about half the depth of the former, immediately above bases of palpi; jowls and basioccipital region mummy-brown or cinnamon-brown, clothed with similarly coloured hair; facial beak of moderate length, blunt (not sharp-pointed) at tip, which is shining black or blackish-brown, proximal three-fourths of beak enveloped, except below, with a matt, dark seal-brown, smooth (not transversely rugose) covering; occiput light buff (immediately adjacent to posterior orbits ochraceous-buff), clothed with glistening, ochraceous-buff hairs, which become brownish towards tips; first and second segments of *palpi* sepia-coloured or dark brown, clothed with reddish-brown or dark brown hair, and together longer than or at least as long as distal segment, latter blackish-brown or black (sepia-coloured at base), moderately swollen beyond proximal fourth, and sparsely clothed, at least on outer side and at base, with short, reddish-brown hairs; *antennæ* warm buff, second segment with a circlet of russet-coloured hairs at distal extremity, third (compound) segment slender, showing but little increase of depth at base. *Thorax*: dorsum of main portion (scutum) vinaceous-buff pollinose, with, as shown in text-fig. 9, on anterior two-thirds a pair of fairly broad, black or blackish-brown longitudinal stripes, and on each side, behind transverse suture, a pair of similarly coloured spots, the larger of which occupies postalar callus, while the other, much smaller spot is situate above base of wing, just behind outer extremity of transverse suture; a short distance in rear of latter, each longitudinal stripe becomes partially obliterated or is tapered off obliquely from in front outwards, and is then continued to prescutellar groove by a narrower and paler extension, each extension ending on anterior wall of groove in a somewhat ill-defined, darker, spot-like termination, which is in contact with its fellow; scutellum black or blackish-brown, its outer extremities silver-grey pollinose on a pale ochraceous-

Text-figure 9.



Pantophthalmus variegatus Austen, ♀. × 1⅓.

buff ground; dorsum of scutum clothed with ochraceous-buff hair, stripes, spots, and scutellum clothed with brownish or dark brown hair; humeral calli warm buff or cream-buff, outer extremities and a spot on upper surface at base dark brown; pleuræ and pectus mummy-brown, clothed with similarly coloured hair. *Abdomen*: first four tergites, at least in typical series, ochraceous-orange or orange-rufous, their lateral extremities, which are somewhat deflexed, black and sharply defined, with a transversely elongate, silvery-white spot in posterior angle of each tergite, spots on fourth tergite smaller than the others and sometimes indistinct; remaining tergites, including ovipositor, mummy-brown, a larger or smaller area in centre of base of fifth tergite ochraceous-orange or orange-rufous; sixth and seventh tergites, fifth tergite except area just mentioned, and lateral borders of preceding tergites, except silvery-white spots, clothed with dark brown, blackish or black hair; first tergite, except lateral extremities, thinly clothed with fine, decumbent, glistening ochraceous-buff hairs, remainder of ochraceous-orange or orange-rufous area of dorsum very sparsely clothed with short or minute hairs of similar colour; venter mummy-brown, thinly clothed with fine, dark brown hair. *Wings*: markings very similar to those exhibited by *Pantophthalmus batesi* Austen (*cf.* figs. 9 and 2); costa, from a short distance beyond base, mainly cinnamon-coloured; veins elsewhere partly mummy-brown, partly sepia-coloured, except in pale areas where they are cinnamon-buff; teguliform swelling at base of costa ochraceous-buff, large and conspicuous. *Halteres* (in dried condition at any rate) sepia-coloured. *Legs*: first segment of all tarsi (except extreme tips), also extreme bases of following segments in case of front pair, honey-yellow, ochraceous-buff or cream-buff, clothed with short, glistening, cream-coloured or cream-buff hair; legs otherwise clove-brown or chocolate-brown (last four segments of hind tarsi sometimes blackish-brown or black), clothed with fine, similarly coloured or blackish hair, which is closely set on hind femora and tibiæ, so that these segments, or at least hind tibiæ, have a furry appearance; claws black, sometimes russet-coloured at base; pulvilli and empodia ochraceous-buff.

Brazil. Holotype, precise locality unknown, before 1849 (*Mrs. Noel*); one paratype, Parana, about 1906 (*E. Dukinfield Jones*); a second paratype, precise locality unknown, *ex coll.* J. Bigot (presented by Mr. J. E. Collin, F.E.S.). A third paratype, without any indication of locality, but bearing two labels, each with the words "*seticornis*, Wied.", and in one case with the addition of "E Mus. Saund.: 1867. 10*d*" in J. O. Westwood's handwriting, is in the possession of the Hope Department, University Museum, Oxford. The holotype is the specimen called by F. Walker (List Dipt. Ins. in coll. Brit. Mus., Pt. i. p. 210, 1848) *Acanthomera seticornis* Wied. The paratype from the Bigot collection was placed by its original owner above the label "*A. frauenfeldi*, Schiner." It may be of interest to note that, in the wings of the paratype from Parana, the second posterior cell is closed and petiolate, although in all other respects, apart from *post-mortem* shrinkage of the abdomen, the specimen is normal.

While the thoracic spots in the case of *Pantophthalmus variegatus*, ♀, are similar to those exhibited by both sexes of *P. vittatus* Wied., though the posterior lateral spot is much larger in the species characterized above, the distinctive thoracic stripes in *P. variegatus* will at once serve to separate it, not only from *P. vittatus*, but also from any other Pantophthalmid in which at any rate the female sex is known.

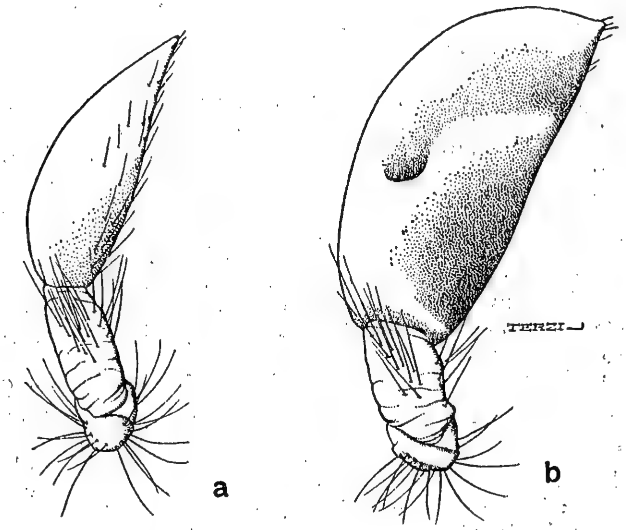
It only remains to add that nymphs of the usual species of Gamasid mite, albeit in small numbers, are present on the abdominal tergites of at least two of the paratypes, as well as on those of the holotype of *P. variegatus*.

Genus **Rhaphiorhynchus** Wiedemann.

Rhaphiorhynchus Wiedemann, Diptera Exotica, Pars i. p. 59 (1821).

In spite of the lapse of more than a century since this genus was first described, the genotype, *Rhaphiorhynchus planiventris* Wied., is still the only species that can be assigned to it; as explained below (*cf.* p. 597), it now seems more reasonable to found a distinct genus for *Rhaphiorhynchus rothschildi* Austen,

Text-figure 10.



Left maxillary palpus of *Rhaphiorhynchus planiventris* Wied.; *a*, ♂; *b*, ♀. Inner (ventral) aspect in each case.

which was described in 1909. At the same time, the distinctive shape of the terminal segment of the palpus in *Rhaphiorhynchus planiventris*, especially in the female, precludes any thought of including this species in the genus *Pantophthalmus*. As shown in fig. 10, the distal segment of the palpus in *Rhaphiorhynchus*, while distinctly swollen and fusiform in the male, is enormously dilated in the opposite sex and, viewed from below, is decidedly reniform. A prominent and sharp-pointed facial beak, and a well-developed subfemoral spine on the hind legs are present in both sexes.

Rhaphiorhynchus planiventris Wied.

Rhaphiorhynchus planiventris Wiedemann, Dipt. Exot. i. p. 60, Tab. ii. fig. 1 (1821).

Acanthomera crassipalpis Macquart, Mém. Soc. roy. des Sc., de l'Agric. et des Arts de Lille, Année 1846, p. 43, Tab. i. fig. 3 (1847).

Acanthomera bigoti Bellardi, Saggio di Ditterol. Messicana, Appendice, p. 16, Tav. iii. fig. 10 (1862).

The specific identity of *Acanthomera crassipalpis* Macq. and *A. bigoti* Bell. with *Rh. planiventris* Wied. was recognized long ago by Baron C. R. Osten Sacken (Biol. Centr.-Amer., Diptera, vol. i. p. 66 (1886)).

The undermentioned specimens of *Rh. planiventris* are in the British Museum (Natural History):—One ♂, David, Chiriqui, Panama, and one ♀, Bugaba, Panama, 800–1500 ft.—both collected by Mr. *G. C. Champion*, and determined by Osten Sacken (*loc. cit.*); one ♀, Provincia Sara, Santa Cruz de la Sierra, Bolivia, February–April, 1904 (*J. Steinbach*). From the Bigot collection, Mr. J. E. Collin has kindly presented the type of *Acanthomera crassipalpis* Macq. (a ♀, stated by Macquart, *loc. cit.*, to be from Guatemala), and two additional ♀♀, from Chontales, Nicaragua, all of which, with a ♀ of *Pantophthalmus* (*Acanthomera*) *frauenfeldi* Schin. (*vide supra*, p. 565), were placed by Bigot above a label inscribed "*Acanthomera crassipalpis* Macq., n. sp. ♀."

In the Hope Department of the University Museum, Oxford, this species is represented by three ♀♀, of which two are from Chontales, Nicaragua, 1870 (*E. M. Janson*), while the third is simply labelled "America aeq."

The Liverpool School of Tropical Medicine possesses a ♀ of *Rh. planiventris* from the R. Amazons, Brazil, "on board S.S. 'Hildebrand,' 25. ii. 1920, 6.30 p.m." (*Dr. Clarke*).

All three Oxford specimens show the nymphal stage of the usual species of Gamasid mite on the dorsal surface of the abdomen; in two instances, however, only a single parasite is visible, while in the third case the nymphs number less than a dozen.

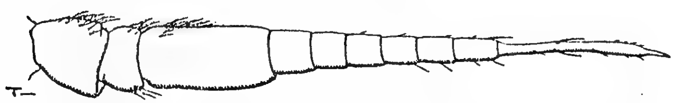
Genus Atopomyia *, nov.

Distinguished, at least in ♂ sex, from both *Pantophthalmus* Thunb. and *Rhaphiorhynchus* Wied. by the narrow, elongate shape of the body, and the form of the third (compound) segment of the antenna. The latter, instead of its broader (proximal) portion being more or less abruptly truncate (or tapering quickly to a point), and bearing terminally a fine, setiform arista (as in

* ἄτοπος, strange, extraordinary, μυῖα, a fly.

Pantophthalmus ♂), or being lanceolate (as in *Rhaphiorhynchus planiventris* Wied., ♂, *apud* Macquart, Mém. Soc. Roy. des Sc., de l'Agric. et des Arts de Lille, Année 1838, 2ième Partie, pl. 20. figs. 3, 3 *a*, 1838), is narrow and subulate, with its terminal annulus elongate, rod-like, abruptly attenuate and pointed at the tip, and bearing a few minute hairs towards the end, in addition to a longer recumbent hair above and below, just before the middle. Distinguished further, from both genera mentioned, by the palpi (at least in ♂) being densely clothed with stiff hair, instead of the distal segment being practically bare; distinguished also from *Rhaphiorhynchus* by distal segment

Text-figure 11.



Left antenna of *Atopomyia rothschildi* Austen, ♂, from the inner side.

of palpi not being characteristically swollen as in that genus, and being decidedly shorter than remaining portion of palpus, instead of *vice versâ*. Face with a large, thick beak, pointed at tip, thickened portion more or less distinctly wrinkled transversely. Dorsum of thorax, at least in ♂ of genotype, devoid of the small or minute, rounded, wart-like tubercles, which, though varying greatly in different species in size and number, are characteristic of the majority of Pantophthalmidæ, though apparently not present in all, at any rate in both sexes. Hind legs with a large subfemoral spine; terminal spine on hind femora very small, at least in genotype.

Genotype—*Rhaphiorhynchus rothschildi* Austen.

Atopomyia rothschildi Austen.

Rhaphiorhynchus rothschildi Austen, Novitates Zoologicæ, vol. xvi. p. 129 (May 1909), and vol. xvii. pl. xv. fig. 1 (December 1910).

Although at the time of describing this striking species the author considered that there were no real grounds for separating it from *Rhaphiorhynchus* (*cf.* Austen, *l. cit.* vol. xvi. p. 130), it seems advisable on further consideration to reverse this view, especially when regard is paid to the important palpal characters to which attention is drawn in the generic diagnosis above.

The type of *A. rothschildi*—a ♂ from Buenavista, Bolivia (*J. Steinbach*)—is in the Tring Museum, and the British Museum (Natural History) possesses a paratype of the same sex from Ecuador (*Buckley*). During the fourteen years that have elapsed since the species was described, no further specimens of it have been added to the National Collection or seen by the author; but it may be noted that two ♂♂ of *A. rothschildi*, from Peru and Chiriqui, Panama, respectively, were in the possession of the late Professor Hermann (*cf.* Hermann, Deutsch. Ent. Z., Jahrg. 1916, Heft i. p. 47, 1916).

According to Lord Rothschild (Nov. Zool. vol. xvii. p. 461, December 1910), *Atopomyia rothschildi* mimics the Hymenopteron *Pepsis elevata* Fabr., which is doubtless the explanation of the curious contrast in its general *facies* presented by this species, as compared with any other Pantophthalmid at present known.

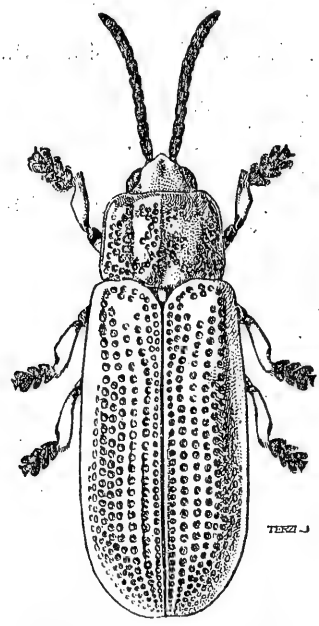
31. New Cryptostome Beetles. By S. Maulik, F.Z.S.

[Received May 7, 1923: Read May 29, 1923.]

(Text-figures 1–8.)

In the present paper are described one new genus and six new species of Hispinæ and Cassidinæ. Two facts are interesting: the association of two Hispids of the same genus, structurally different but having strong resemblance in superficial colouring, in the same food-plant; and secondly, the new Cassid beetle from Palestine possesses a claw-structure which is not found usually in this group of beetles. These facts are described in detail below.

Text-figure 1.



Dorsal view of *Callispa almora.*

Callispa almora, sp. n.

Body elongate. Colour shining yellow; mouthparts, antennæ, trochanter, apices of femora, and bases of tibiæ pitch-black; underside brown.

Head smooth, impunctate, and slightly produced between the bases of the antennæ. The antennæ are hardly thickened towards the apex, the apical joint pointed, subnitid; the third joint is longer than the second, but slightly shorter than the first and second combined. *Prothorax* almost as long as broad, slightly narrowed in front; the basal margin bisinuate, the sides straight and margined, the anterior angles rounded, the posterior acute. The upper surface with a longitudinal depression on each side, and also with one in the middle at base; in the lateral depressions are some coarse punctures; the middle longitudinal area slightly convex, but having similar punctures except along a narrow middle line; some of the punctate portions are slightly depressed. *Scutellum* oblong, sides straight, anterior edge broadly rounded; surface smooth, shining, impunctate. *Elytra* very slightly broader at base than the prothorax, parallel-sided, punctate-striate; besides the short scutellar row on each elytron there are eight rows at the base and ten rows in the middle; the interstices are smooth and flat. The punctures are much stronger in the middle area than elsewhere. *Underside* smooth, shining, impunctate except for a few coarse punctures on the sides of the thoracic sterna.

Length 5 mm.

India: the Himalayas, Almora, 4500 ft., Khaula (*H. G. Champion*).

Type in the British Museum.

Described from six examples.

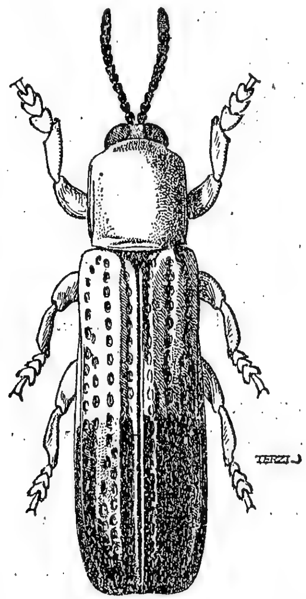
This species is related to *C. nigritarsata* Maulik, which is from Ceylon, but differs in the coloration, the relative lengths of the second and third joints of the antennæ, and the structure of the prothorax with its punctation.

Downesia sasthi, sp. n.

Body elongate, narrow. Colour shining brown, with the eyes, antennæ, and the apical area of the elytra black.

Head with the eyes large; the interocular space smooth, with a few punctures. The antennæ are short, scarcely reaching the middle of the pronotum, very slightly thickened towards the apex, and covered with hair, more so towards the apex; the first joint rounded, the second longer than the third, the third, fourth, fifth, and sixth almost equal to each other in length, from the seventh to the eleventh slightly thickened, the last the longest and bluntly pointed. *Prothorax* quadrate, longer than broad, very slightly narrowed behind, the sides parallel and margined; the anterior angles rounded, the posterior ones emarginate. Basal margin at the middle deeply channelled. The upper surface sparsely and confusedly punctate, there being less punctures in the middle than elsewhere; the front rounded margin impunctate. *Scutellum* small, impunctate. *Elytra* broader at the base than the prothorax, parallel-sided, very slightly constricted in the middle; at the rounded apical angles the margin is explanate. Each elytron has six rows of punctures on the apical surface: the first runs along the suture right to the apical surface, where it does not become double, the next row of punctures divides itself into two on the black apical surface of the elytra, then another row commencing from the humerus soon becomes double, finally there is the marginal single row; on the apical area the third interstice is raised into a short, sharp costa; all the interstices have the appearance of being slightly raised; on the brown portion of the elytral surface the punctures are surrounded by a black ring, and hence appear much larger than those on the black area; a scutellar row is absent. *Underside* smooth, shining, impunctate.

Text-figure 2.



Dorsal view of *Downesia sasthi.*

The tarsi of the front legs almost equal in length to the tibiæ and larger than those of the other legs. The claw-joint of the tarsus projects beyond the third joint.

Length 5–6 mm.

W. Himalayas: Kumaon (*H. G. Champion*). Found on *Thysanolæna agrostis.*

Type in the British Museum.

Described from nine examples.

These nine examples were sent with four examples of *Downesia gestroi* Baly, all found in sheaths of *Neyraudia*, to

Mr. G. C. Champion, who was good enough to afford me the opportunity of examining them.

The superficial resemblance between *D. gestroi* and *D. sasthi* is so remarkable that they were considered as the same species. The structural differences between them are considerable, and warrant the erection of a new species. The close association of these two structurally different forms, but possessing a strong superficial resemblance, in the same food-plant is interesting, and is suggestive of some form of mimicry. *D. ceylonica* Maulik, *D. ratana* Maulik, and *D. kanarensis* Weise have also similar coloration of the elytra, viz. the apical portion is black while the basal is brown.

Kari, gen. nov.

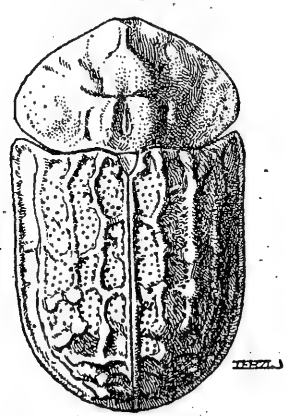
This genus is erected for the insect of which a detailed description is given below, according to the following characters: (1) the shape of the body, parallel-sided, rounded posteriorly, the pronotum transversely elliptical; (2) the structure of the antennæ, which partly lie in the channel on each side of the cavity in which the head is imbedded; (3) the peculiar structure of the tarsus, in which there is no felt covering on the underside, and the deeply bilobed character, especially of the third joint, is absent. The structure of the tarsi suggests that they have been adapted to a desert life. The drab colour of the insect seems to support this view. At present there are no data available with regard to the larvæ and the bionomics of the insect. By the shape of the body and the antennal channels it is related to the genus *Glyphocasis*, but the structure of the tarsus places this genus in a unique position.

Kari brunnea, sp. n.

Body oblong, parallel-sided, rounded posteriorly; the front of the pronotum slightly drawn forwards; in profile the dorsal side of the insect has a slight elevation posteriorly. Colour dull brown; the posterior undulated edge of the pronotum opposing the anterior similarly undulated edge of the elytra, black; the eyes, mouthparts, and the five apical joints of the antennæ black or piceous.

Head imbedded in a hollow, each side of which forms a channel in which lie the six basal joints of the antennæ. The clypeus flat, indented with large coarse pits, some of which are confluent with each other and bear a few erect hairs. The antennæ pass just beyond the base of the prothorax on the underside, the first joint thickened, club-shaped; the second small, rounded; the third longer than the fourth, which is equal in length to the fifth; the sixth slightly shorter than the fifth; seventh to eleventh joints form an elongated thickened club. The whole antenna is sparsely covered with short, erect, whitish hairs. *Prothorax* transversely oval, broader than long, as broad at the base as the elytra; the middle of the slightly drawn out front edge with a very shallow emargination; each half of the basal margin bisinuate, the lateral margins rounded. The edge all round, except the basal black portion, bears short, erect, whitish hairs, is uneven, more so at the lateral rounded portions, and is generally darker than the ground-colour of the pronotum. The upper surface is very uneven, having the following structure: the middle of the basal area is enormously raised into two high peaks (they being the highest points of the surface) with a depression between them; on each side of these there is a broadly convex, uneven, and oblique area sloping down to the edge; anterior and posterior to these swollen areas are deep depressions; in front the surface also slopes down, and is broadly convex and tuberculate, narrowing down in the middle into a longitudinal ridge which reaches the front edge; on either side of this ridge the surface is deeply depressed; the frontal area, including the swollen and the depressed portions, contain

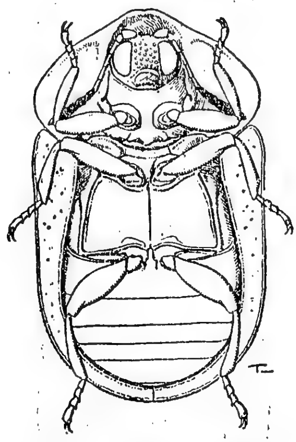
Text-figure 3.



Dorsal view of *Kari brunnea*.

round black spots; the posteriorly situated depressed areas also contain similar spots; some of these may be impressed pits or punctures. *Scutellum* triangular, with the surface fairly plane. *Elytra*: the front black edge is bisinuate on each side and roughly serrate. The edge all round is roughly serrate, darker than the body-colour, and bears short, erect, whitish hairs. Each elytron is punctate, and with costæ and tubercles. The whole surface is very sparsely scattered over with short, erect, whitish hairs which are visible under a high power. The suture is strongly raised. On each elytron there are four costæ: the first, that nearest to the suture, is the strongest, running the whole length parallel to the suture, and in its posterior portion at several places swollen into tubercles and joined to the suture and to the second costa by many short transverse costæ; the second and third costæ are feebler, and arising from the humerus they break up into tubercles posteriorly without reaching the apical area of the elytron; the fourth costa is hardly developed at the base, but more strongly so posteriorly, bending round to join the first costa on the apical area; between the fourth costa and the margin,

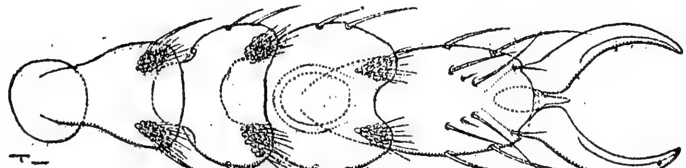
Text-figure 4.



Ventral view of *Kari brunnea.*

which is also raised, the surface is much depressed, containing deeper punctures and much broken up at various places by swellings. *Underside* more shiny than the upperside. The epipleuræ of the elytra and the under surface of the pronotum bear a few scattered dark punctures. The legs are very sparsely

Text-figure 5.



Under surface of tarsus of *Kari brunnea.*

scattered over with short, erect, whitish hairs. The first joint of the tarsus is constricted at the base and dilated at the apex; the second is broader than long, slightly emarginate at the apex; the third is similar to the second in structure, not deeply bilobed as is usual in the Chrysomelidæ; the claw-joint arises from the base of the third, long, more or less cylindrical, projecting much beyond, as broad at the base as at the apex; the claws are simple. There is no felt covering underneath, as is usual in the Chrysomelidæ. Viewed from above, the tarsus appears to have uniform breadth throughout its length, and is covered with stiff, erect hairs. Each side of the first, second, and third joints has a little strongly chitinized projection which is reminiscent of the lobes of the joints; these projections are clearly visible when the tarsus is viewed sideways, and on their underside they bear tufts of bristles, so that there are altogether three pairs of them.

Length 5 mm.

Locality. Palestine, 10 miles east of Jerusalem, 1000 ft., 17. iv. 1922 (*P. A. Buxton*).

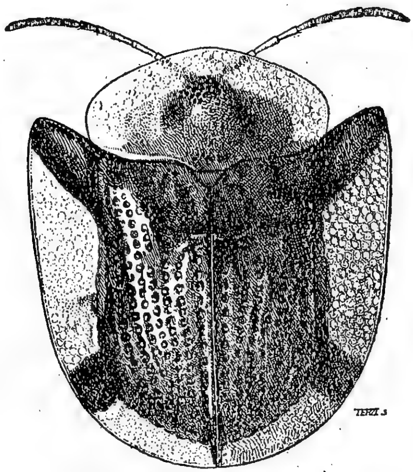
Type in the British Museum.

Described from one example.

CASSIDA RATI, sp. n.

Body subtriangular. Colour yellow-brown; elytra with ill-defined darker patches, the explanate margin at the anterior and posterior angles with deep red-brown patches, the sutural angles deep red-brown; underside (except the legs) shining black.

Text-figure 6.



Dorsal view of *Cassida rati.*

Head with the clypeus triangularly elevated towards the base of the antennæ, otherwise the surface is plane, having stiff, long hairs at the sides. The antennæ pass beyond the anterior angles of the explanate margins of the elytra; the first joint elongate, thickened; the second short; the third, fourth, and fifth almost equal to each other in length; the sixth shorter, slightly dilated at the apex; the seventh still shorter, more thickened; the eighth to eleventh slightly thickened, black, and more hairy. *Prothorax* much narrower than the base of the elytra, broader than long. The sides rounded and front margin widely arched; each half of the basal margin bisinuate and edged with black. The surface is convex, smooth, shining, impunctate, and slightly sloping from the base to the front; on each side of the disc there are two indistinct, roundish, darker patches. The explanate margins are transparent, with a honeycomb structure. *Scutellum* triangular, smooth, impunctate. *Elytra* much broader at the base than the prothorax. A little posterior to the scutellum the surface is raised into a hump (not visible in the illustration). On each elytron there are nine rows of rather coarse punctures: the two nearest to the suture run right up to the end, the others converge and terminate on the apical area of the elytron; besides these rows a few punctures may be said to represent a short scutellar row, and some very coarse pits, more regular posteriorly, along the extreme margin may represent a tenth row of punctures. The interstices are more or less costate, particularly the first two. The surface has some indistinct patches of dark-brown colour; the red-brown fascia on the explanate margin at the anterior angles (which are rounded) continues as a lateral band, joining the similar fascia at the posterior angle. The explanate margins transparent and with a honeycomb structure. *Underside*: the abdominal sternites sparsely covered with brownish hairs; those on the side longer. The claws simple, projecting slightly beyond the bilobed joint.

Length 7 mm.; *breadth* 6 mm.

India: Manipur (*Doherty*).

Type in the British Museum.

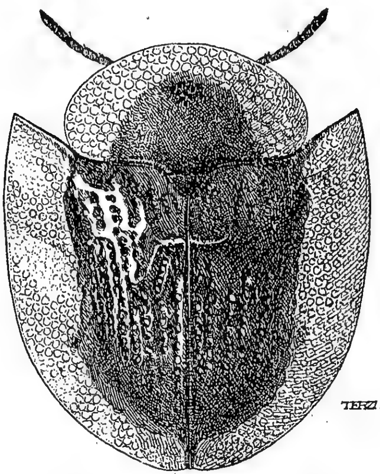
Described from one example.

CASSIDA MANIPURIA, sp. n.

Body subtriangular. Colour yellow-brown, with darker brown patches on the elytra. The anterior lateral angles of the explanate margin of the elytra are very sharp.

Head with the clypeus slightly convex, smooth, impunctate. The antennæ extend beyond the anterior angles of the explanate margin of the elytra; first joint elongate, club-shaped; the second almost as long as the third, constricted at the base a little dilated towards the apex; the third, fourth, and fifth almost equal to each other in length; the sixth shorter; seventh to eleventh a little thicker, more hairy; the last two piceous. *Prothorax* elliptical, much broader than long, the front margin widely arched. The disc convex, slightly sloping from the base to the anterior margin, smooth, impunctate. The explanate margin transparent, with a honeycomb structure. *Scutellum* triangular, smooth, shining, impunctate. *Elytra* much broader at the base than the prothorax. That the anterior lateral angles of the explanate margins of the elytra are acute and sharp is an important character. A little posterior to the scutellum there is a hump (not visible in the illustration). On each elytron there is a short scutellar row consisting of a few punctures, and ten rows of coarse punctures, including the extreme marginal one which consists of a few coarse pits. The rows are not very regular, in some places the punctures being confused. The interstices are more or less costate. The dark brown patches are obsolescent, there being two, one below the humerus and the other at the posterior angle, dark pitch-black; these may form with the obsolescent patches a lateral band. The explanate margins are transparent, with a honeycomb structure. *Underside* uniformly

Text-figure 7.



Dorsal view of *Cassida manipuria*.

brown, with the middle area of the abdomen a shade darker. The claw-joint hardly projects beyond the bilobed joint; claws simple.

Length 7 mm.; *breadth* 6 mm.

India: Manipur (*Doherty*).

Type in the British Museum.

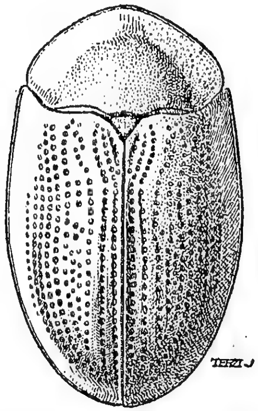
Described from two examples, one of which is defective.

CASSIDA DIMBAKAR, sp. n.

Body elongate-ovate. Colour uniformly brown above; underside black, except the legs and the sides of the abdomen.

Head black, with the clypeus flat. The antennæ hardly reaching the base of the elytra; the first joint thickened, club-shaped; the second smaller; the third, fourth, and fifth almost equal to each other in length; the sixth and seventh slightly shorter; the eighth to eleventh formed into a thickened club, which is piceous. *Prothorax* broader than long, as broad as the elytra at the base, the lateral angles being near the base; the front margin uniformly arched. The upper surface slopes from the base to the anterior margin, convex and impunctate; the explanate margin with a honeycomb structure. *Scutellum* small, triangular, smooth, and impunctate. *Elytra* ovate, with the sides and the explanate margins sloping down. On each elytron,

Text-figure 8.



Dorsal view of *Cassida dimbakar*.

besides a very short scutellar one, there are eleven other rows of punctures; the fourth row is irregular and confused, the rows meeting in pairs on the apical area. The interstices more or less costate. *Underside*: abdominal sternites slightly covered with hairs.

Length 5·5 mm.

India: ex coll. Linn. Soc.

Type in the British Museum.

Described from one example.

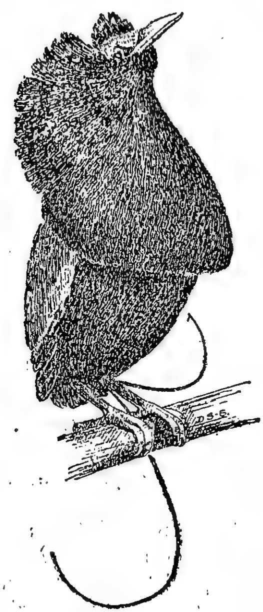
32. On the Display of the Magnificent Bird-of-Paradise, *Diphyllodes magnifica hunsteini*. By D. Seth-Smith, F.Z.S.

[Received June 9, 1923: Read June 12, 1923.]

(Text-figures 1–4.)

At a meeting of this Society, held on February 20th, 1923, I made some remarks on the nuptial display of the various species of the Paradiseidæ, and referred especially to that of *Diphyllodes*, of which there was a male example of the form

Text-figure 1.



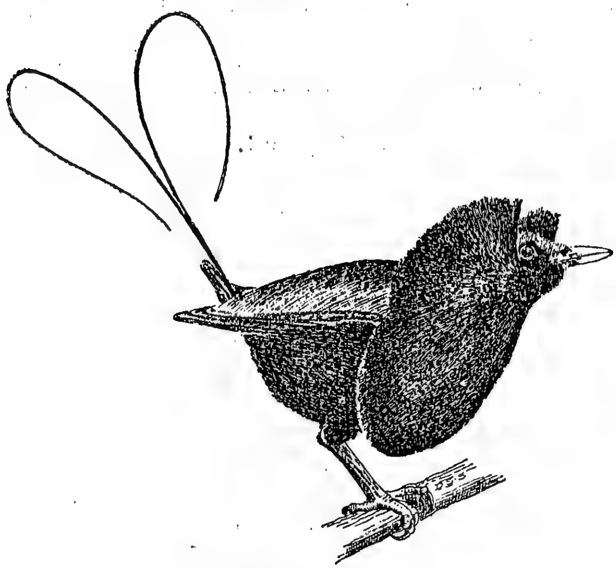
First attitude of display.

from south-east New Guinea (*D. m. hunsteini*) in the Society's collection. The remarks then made and the drawings exhibited were the result of brief observations, the bird having only recently commenced to display; but since then it has given many exhibitions, having been displaying on and off for the past five or six months.

Further observations have revealed certain details in the attitude adopted that were not at first apparent.

Dr. Philip Manson-Bahr has spent many hours in sketching this very difficult subject, and his series of beautiful coloured drawings now exhibited will be fully explained by him *. For my own part I decided to try and photograph the bird during display, knowing that in the dull light in which the cage is situated and the presence of intervening bars it was impossible to obtain presentable pictures, but hoping to secure records

Text-figure 2.



Second attitude of display.

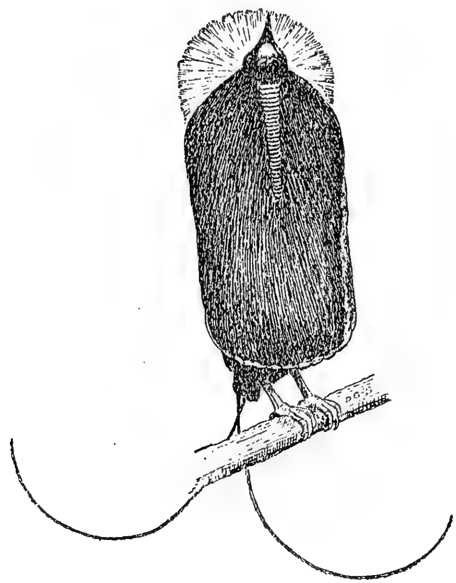
of the different positions adopted, from which it would be possible to make accurate drawings.

Before describing the display of this species it will be as well to give a brief description of the bird itself. About the size of a Starling, it has the top of the head covered with velvet-like feathers of a brownish colour; the back is metallic reddish chestnut, becoming orange on the lower back, the wing-coverts yellow with a distinct shade of orange, the abdomen and under tail-coverts blackish purple. The tail, which is very short

* Dr. Manson-Bahr's series of coloured drawings of this bird have been presented by him to the Zoological Society and placed in the Library.

except for its two middle feathers, is dark brown, the central pair of feathers being produced into very narrow plumes some nine inches in length and of a brilliant metallic green on the upper surface—they cross one another and spread outwards in opposite curves. Covering the under surface of the body from the throat, and occupying the whole of the breast, is a shield of rich velvet-like green, the lower feathers tipped with metallic blue, and down the middle of this, commencing below the black throat, is a narrow band of square-ended feathers of a rich metallic emerald-green. From the hind neck grows a broad

Text-figure 3.



Final attitude with mouth open.

fan-shaped hood of pale yellow plumes, with the texture of spun glass, flanked on each side by tufts of reddish-brown feathers. The bill and feet are blue, and the inside lining of the mouth delicate green.

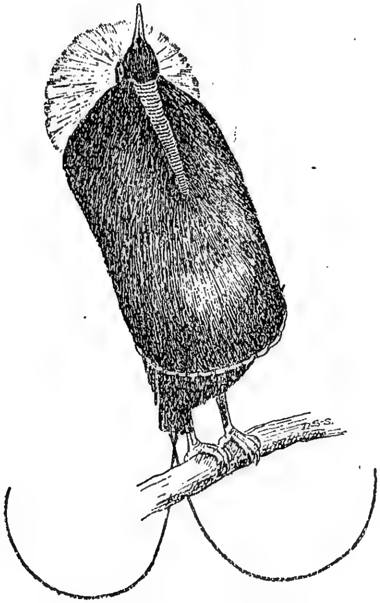
Birds-of-Paradise comprise one of the few groups of Passerine birds that are polygamous, and where polygamy prevails in birds it is generally accompanied by great adornment of the male sex. Various attitudes of display are adopted, calculated to exhibit these adornments to the best advantage.

The methods of adornment of the males in the Birds-of-Paradise are very varied and the attitudes adopted during display differ in every genus, that of *Diphyllodes* being entirely unlike that of any other Bird-of-Paradise so far as our knowledge of these birds goes; and, before the specimen now in the Society's Gardens commenced to display, this remarkable performance had apparently never been witnessed.

There is more than one attitude of display assumed in the case of most birds, and in *D. m. hunsteini* there appear to be three or four which, as a rule, follow one another in regular sequence, though frequently the final attitude is assumed without the others.

When inclined to display the bird sits on the perch with the plumage rather relaxed and utters two or three notes sounding

Text-figure 4.



Final attitude with mouth closed.

like *qua-qua-qua*, and then suddenly adopts the attitude depicted in text-fig. 1, the pectoral shield being brought into prominence and its sides thrown up considerably above the level of the head—at the same time the tail being thrown sideways. In the second stage the body is brought into a horizontal position, the sides of the pectoral shield erected, and the central tail-feathers held above the level of the body with their brilliant metallic surfaces visible from the front (text-fig. 2).

In a third stage, which is not often observed, the head is thrown further back and the erected tail more forward, the two long plumes reaching to the head and being swayed from side to side. In both of these and in the final stage the bill is from time to time opened to exhibit its delicate green lining.

In the final stage, which is depicted in text-figs. 3 and 4, a complete transformation takes place, the body being suddenly brought into an erect position, the nuchal hood of pale yellow feathers flashed into prominence above the head, the pectoral shield lowered to form a broad ribbon-like strip of bright green, down the centre of which now appears a narrow band of iridescent feathers of emerald-green or brilliant blue according to the angle of the light in which it is viewed, while at the lower extremity of the shield appears a narrow edging of the same hue.

33. The Brain of the Zeuglodontidæ (Cetacea). By Raymond A. Dart, M.Sc., M.B., Ch.M., Professor of Anatomy, University of the Witwatersrand, Johannesburg; with a Note on the Skulls from which the Endocranial Casts were taken. By C. W. Andrews, D.Sc., F.R.S., F.Z.S., British Museum of Natural History.

[Received May 18, 1923: Read June 12, 1923.]

(Text-figures 1–24.)

Table of Contents.

1. Introduction.

"The *Cetacea* are connected with the marine Carnivores through the genus *Zeuglodon*, as Huxley has shown, and the points of resemblance are so marked that the affinity cannot be doubted" (O. C. Marsh, 1877).

It has been suggested, in the past, that these water-living forms, which preserve in their skeletal parts characteristics linking them with the ancestors of modern Carnivora, were the actual ancestors of the whales and the dolphins, *i. e.*, the Cetacea. The Zeuglodonts were therefore grouped together as the Archæoceti. This suggestion of a Carnivore (or Creodont) ancestry seems to have been universally admitted until Matthew and Gregory (1910) pointed out various characteristics which seem to link the Zeuglodontidæ more closely with Insectivore antecedents. In the meantime, the intimacy of the relationship between Zeuglodontidæ and Cetacea has been reaffirmed by numerous observers, including amongst many others Abel (1905–1913) and Winge (1919, 1921).

Previous investigation of the group has naturally centred around the osteological remains, and has shown (Andrews, 1907) that they probably arose "on the northern shores of the Ethiopian land in the early part of the Eocene period," and that "by the end of the Middle Eocene the true Zeuglodonts had come into existence, and had spread rapidly over the earth, their remains being found in the upper part of the Eocene of America, England, and New Zealand."

Since the appearance of Professor G. Elliot Smith's important contribution to the study of the form of the endocranial cast (1903) no new feature of the cerebral anatomy of these forms has been recognised, so far as I have discovered, although Stromer (1908) has figured what is apparently a unique natural endocranial cast in a form which he styles *Zeuglodon osiris*.

Shortly after the publication of Professor Elliot Smith's article, Mr. H. J. L. Beadnell gave him an almost perfect natural endocranial cast of a Zeuglodont collected in the Egyptian Fayum at the locality known as the Gar-el-Gehannem. Professor Elliot Smith kindly placed it at my disposal some time ago. I was assisted in the "development" of this natural cast by Professor D. M. S. Watson, who carefully removed most of the adherent bone and matrix, giving the result which has been accurately reproduced by Miss Davison in text-figs. 1, 2, and 3. This specimen has since been given to the British Museum by Professor G. Elliot Smith and is distinguished by the collection number M. 12123. The majority of the remaining figures have been drawn by Mr. Poulton, artist to the Anatomical Institute of University College, London.

Owing to the courtesy of the British Museum officials, of Dr. A. Smith Woodward, and especially of Dr. C. W. Andrews, who has assisted me at every turn in this work, I have been able to draw upon the paleontological resources of that institution. The Zeuglodont material there has been examined and extremely satisfactory casts made of the brain-cases, through the skilful work of Mr. L. E. Parsons.

The conclusion of this research would have been impossible apart from the courtesies that have been extended to me not only by the above-mentioned persons, but also by Sir Arthur Keith and Mr. Burne of the Royal College of Surgeons. To one and all I tender my grateful thanks.

2. Material.

One of the most important results that has emerged from the research is the definiteness with which we can now determine certain different Zeuglodont species. The species *Zeuglodon osiris* Dames, 1894, was originally known from its lower jaw and certain other skeletal remains. Stromer (1903) correctly identified the skull of this creature, having in his possession an almost complete head. In a later paper, however, Stromer (1908) has caused confusion by referring an entirely different Zeuglodont to the same species. It became necessary, therefore, to discover which form actually was *Zeuglodon osiris* and, working with this information, to arrange our series.

In this matter two lines of evidence have substantiated our findings. Elliot Smith (1903) described an imperfect endocranial cast (M. 8150) which was known to have come from a skull (M. 8150) determined as *Zeuglodon osiris* Dames by Dr. Andrews in Egypt at that time. Fortunately, casts both of the cranial cavity and of the skull itself were amongst the British Museum material. In addition there were two skulls in the Museum, both of which were termed *Zeuglodon osiris*. A more intimate survey of these two skulls (M. 10228 and M. 10173) has rendered necessary their separation into two different species. Further, by means of the matrix in which they are embedded, Dr. Andrews is able to recognise them as probably coming from two entirely different beds of the Middle Eocene epoch. The first (M. 10228) possesses the same characters as M. 8150, and is actually *Zeuglodon osiris* Dames (see text-fig. 14) from the Qasr-el-Sagha Series. These two skulls (M. 8150 and M. 10228) conform entirely to the description of that type given by Stromer (1903).

This primary orientation having been achieved, it became apparent that the second skull (M. 10173), hitherto classed indiscriminately as *Zeuglodon osiris*, was not *Zeuglodon osiris* but another form altogether. The matrix in which it is embedded shows that it probably comes from the Birket-el-Qurun Series (Operculina-Nummulite beds). Its characters are intermediate between those of *Zeuglodon osiris* of the Carolia beds and *Prozeuglodon atrox* Andrews (M. 9266) from the Ravine beds. The endocranial casts confirm these facts; indeed, it was the serial conformity of the casts which led us to a re-examination of the osteological features.

Therefore, three of the endocranial casts here described come from skulls whose osteological features are known. Further, as a group, these three skulls and their casts may be conveniently regarded as a phyletic series. In view of this fact, Dr. C. W. Andrews has kindly written an account of the osteological features of the new form (M. 10173), which we will call provisionally *Zeuglodon intermedius*, sp. nov., and has stated its geological horizon to have probably been the Birket-el-Qurun series (*vide* p. 35, 'The Topography and Geology of the Fayum Province of Egypt,' H. J. L. Beadnell, Survey Department, Cairo, Egypt, 1905).

3. The Two Endocranial Casts unaccompanied by Osseous Remains.

Unfortunately there are no bony remains associated with the natural cast (M. 12123) spoken of at the outset. This cast, although belonging to some Zeuglodont, is so entirely different from any one of the phyletic series that it certainly comes from a species of Zeuglodont not known in the British Museum collection. Lack of information prevents our associating it with any other Zeuglodont hitherto described. This cast presents characters which indicate its affinity with the natural cast (M. 12066) described by Elliot Smith (1903)—which also was unaccompanied by any osseous remains—rather than with any member of this so-called phyletic series. This natural cast does not come from another member of the same species as that described by Elliot Smith, nor is it an endocranial cast of *Zeuglodon osiris.* Comparison with a duplicate (M. 12066) of the natural cast described by Elliot Smith and with *Zeuglodon osiris* (M. 10228) demonstrates a wider degree of separation from both of these than could be accounted for on a specific differentiation alone; we may be dealing here with different genera.

In the case of these casts (M. 12123 and M. 12066) the absence of knowledge concerning the skeleton and the exact horizon from which they have come makes it an invidious matter to establish new species. At the same time it is necessary, in order to avoid confusion in description, to associate some name with each of these casts since they represent at least different species, if not genera. Since we owe to Professor Elliot Smith our first detailed account of the brain in the Archæoceti, and especially the recognition that "the differences" (*i.e.*, between the endocranial cast of *Zeuglodon osiris* and the natural cast (M. 12066) in his hands) "are sufficiently pronounced to indicate a generic distinction between the two specimens"; I propose to term the form from which this type of cast is derived *Zeuglodon elliotsmithii*, sp. nov. The second natural cast (M. 12123)—the one which Professor Elliot Smith has given to me for description—I will call *Zeuglodon sensitivus*, sp. nov., since it was in this cast that a marked hypertrophy of the trigeminal apparatus was first recognised.

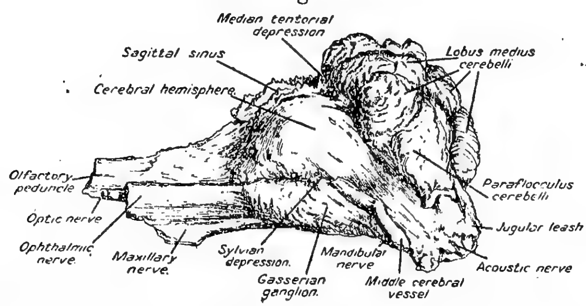
3. *a*. Zeuglodon sensitivus, sp. nov. (M. 12123.)

The most complete endocranial cast of a Zeuglodont yet discovered is that represented by Stromer (1908) *in situ* in the skull of what he has there called *Zeuglodon osiris.* It is not the *Zeuglodon osiris* of his earlier (1903) paper, but more nearly resembles the *Prozeuglodon atrox* Andrews or is intermediate between *Prozeuglodon atrox* and the *Zeuglodon intermedius* of this paper.

The peculiar resemblance of the general configuration of the fore-brain and olfactory peduncles in the Zeuglodont brain to the corresponding regions of the reptilian brain was emphasized by Elliot Smith (1903), and is shown to distinct advantage in the lateral aspect of the natural endocranial cast (text-fig. 1) here under description.

This appearance is accentuated by the apparently reptilian "lobus olfactorius" formed by the anterior part of the cerebrum in Stromer's specimen. This particular resemblance is probably superficial. Instead of passing with a gradual expansion into the front end of the hemisphere as the stalk of a pear is attached to the smaller end of the fruit, the olfactory peduncle in the Zeuglodont is attached to the hemisphere on its ventral surface in the characteristically mammalian fashion, in front of the area of which the still prominent tubercula olfactoria form a part (see text-fig. 3). Behind the position of the attachment of the olfactory peduncle there is an obvious depression in the lower and anterior part of the lateral aspect of the cerebral hemispheres, which I consider to be a definite Sylvian depression (in the sense

Text-figure 1.



Lateral view of natural endocranial cast of *Zeuglodon sensitivus*, sp. nov. M. 12123. About ⅓ nat. size.

that that term is used in the lower Mammalia). This view is corroborated by the fact that the groove is occupied by the large middle cerebral vessels. Stromer's specimen shows not merely a large portion of the endocranial cast, but also a mould of the whole interior of the brain-case, including the olfactory peduncle from its origin in the olfactory bulb in its insertion into the brain. The length of the olfactory peduncle there is more than double the antero-posterior length of the cerebral hemispheres themselves, while the relative size and shape of the bulbar terminal dilatation is clearly distinguishable.

I am able to recognise in this cast (M. 12123) that the optic nerves formed the basal angles of Elliot Smith's "prismatic olfactory peduncle" (*vide* "anterior view" inset to text-fig. 2). Although this involves a considerable reduction of the actual dimensions of the olfactory peduncles in cross-section, as stated by Elliot Smith, it is still obvious that the sense of smell was of significant importance to the Archæoceti.

"Zeuglodon ist mindestens zu den hemianosmatischen Säugethieren zu rechnen im Gegensatze zu den anosmatischen Zahn- und Bartenwalen und ist auch durch normal verlaufenden Nasenrachengänge von letzteren unterschieden," says Stromer. In his insistence on the retention of a sense of smell by these creatures, he is justified even though his term "hemianosmatic" seems philologically meaningless.

Along the dorsal border of the lateral aspect of the cast the olfactory peduncle appears to merge into the sagittal sinus, which is continued over the cerebrum towards the anterior border of the cerebellum, where it dips into the "median tentorial depression" and receives veins from the cerebellar surface.

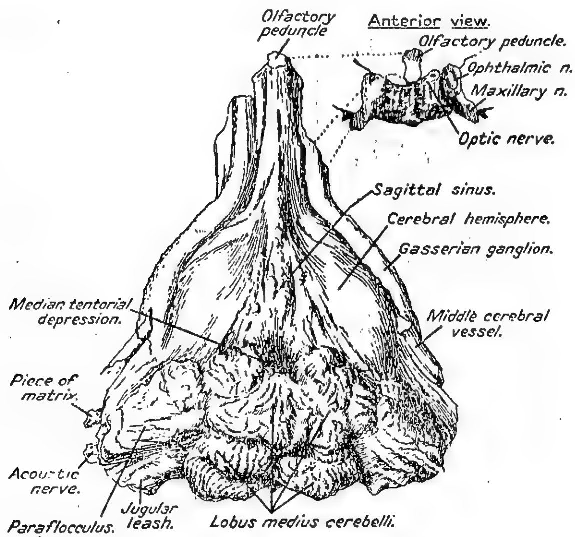
The cerebrum on either side is seen to be bounded by the sagittal sinus above and by the cerebellum posteriorly (which excludes all view of the mid-brain region from the dorsal or lateral aspect). Ventrally there is to be seen anterior to the region of the cerebellum designated "paraflocculus," a rounded roll-like structure continuous anteriorly with the ophthalmic and maxillary divisions of the trigeminal nerve. This bulging mass is a huge *Gasserian ganglion* which rivals the cerebral hemisphere in size, helps to mould the lateral contour of the brain-case, and gives rise to its three proportionately large trunks. Coursing over the lateral aspect of the Gasserian ganglion (well illustrated in text-fig. 1) are the middle cerebral vessels. Between these confines (sagittal sinus above, cerebellum behind, and Gasserian ganglion below) in *Zeuglodon sensitivus* the cerebrum bulges out, displaying a perfectly smooth hemispherical surface with the exception of the previously noted Sylvian depression.

Behind the cerebrum lies the apparently irregular mass of the cerebellum elevated to a height of approximately 15 mm. above the cerebrum. From this it is separated by a tentorial sulcus, which is of especial depth in the mid-line, forming a "median tentorial depression." The most obtrusive feature of the cerebellum from the lateral aspect is unquestionably the lobus floccularis (consisting of the flocculus and the paraflocculus).

Elliot Smith has called this region the "paraflocculus" in his description of the Zeuglodont brain, and this name is retained in these figures. It seems that in most aquatic mammals the paraflocculus is the portion of the lobus floccularis which undergoes greatest expansion. The term paraflocculus may therefore be regarded, for the purposes of this paper, as synonymous with the lobus floccularis.

Despite Bolk's association of the paraflocculus with tail-movements, bears which have no tail (as Elliot Smith has pointed out to me) have, nevertheless, a well-marked paraflocculus. But, whereas the paraflocculus is present in most land-mammals, it becomes especially hypertrophied in all marine Mammalia irrespective of the stock from which they have sprung. Thus creatures so divergent as *Otaria* and *Monachus* (Carnivore), *Trichechus manatus* (of Ungulate origin), and *Phocæna* (probably of Insectivore origin) all possess hypertrophied paraflocculi. This convergent hypertrophy of the same cerebellar region must arise from some cause common to all. Ferrier was one of the first to emphasise the functions of the cerebellum as primarily concerned with equilibration. Ingvar (1918) has supported this conception, and he finds a certain pattern of equilibratory localisation in the organ. This pattern is that of a "compass," a lesion in any given part of the cerebellum entailing a defect in co-ordinating muscle-movement in such a way as to resist falling in that direction; *i. e.*, the animal falls in the direction indicated by the site of the lesion. This theory seems adequate to account for the parafloccular expansion exhibited by marine Mammalia, for

Text-figure 2.



Dorsal and anterior views of natural endocranial cast of *Zeuglodon sensitivus*, sp. nov. M. 12123. About ½ nat. size.

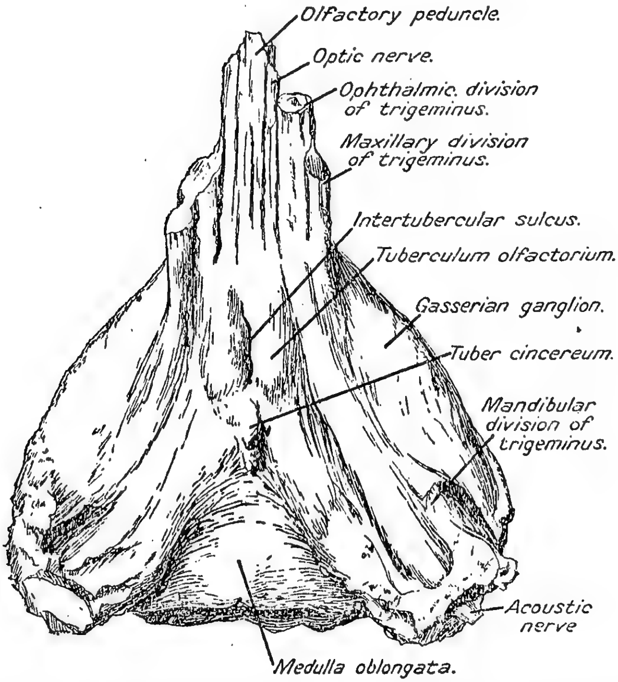
the paraflocculus is situated entirely laterally in the cerebellum, and these creatures are under the necessity of resisting continuously the tendency to "rolling," which the fluid medium postulates. In brief, it is a mechanism evolved to preserve *an even keel.*

The "paraflocculus" is bounded above by the region which in the subsequent account is referred to as the lobus medius. Anteriorly, the paraflocculus abuts on the cerebrum and the Gasserian ganglion; inferiorly, upon the eighth nerve and the petrous temporal and the casts of the foramen lacerum medium and the foramen lacerum posterius ("jugular leash" of the figures). Posteriorly, it is in contact with the exoccipital bone.

Medially from this region can be seen an elevation of the lobus medius of the cerebellum, which is the most posterior structure from the lateral aspect. It probably corresponds to the region which gives rise to the cerebellar tonsil of human anatomy.

Text-fig. 2 presents all those features emphasized by Elliot Smith (1903) in his specimen (*Zeuglodon elliotsmithii* of this paper). This natural cast reproduces very faithfully the convolutional pattern of the cerebellum and the position of the various meningeal vessels, particularly the sagittal sinus. This latter

Text-figure 3.



Ventral view of natural endocranial cast of *Zeuglodon sensitivus*, sp. nov. M. 12123. About ½ nat. size.

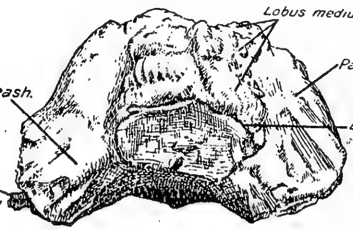
structure was described by Elliot Smith (1903) as the "dorsal rostrum." The knob-like elevations along its course are apparently veins entering it from the diploë of the skull. They bear an extraordinary resemblance to human Pacchionian bodies. Posterior to the prominence of the sagittal sinus and separating it from the cerebellum is again seen the deep "tentorial median depression" already referred to, from which the tentorial sulcus runs laterally on each side separating cerebrum and cerebellum. From this aspect, too, the cerebellum is seen in complete detail—

the enlarged lobus floccularis on either side and in the mid-region the so-called lobus medius. The lobus medius of the cerebellum is shown to be markedly asymmetrical. A bilaterally symmetrical projection into the posterior part of the tentorial median depression possibly represents the lobulus simplex of Bolk. If so, it is very small, and the lobus anticus is completely hidden from sight underneath it.

The hemming in laterally and anteriorly of the hemispheres at their ventral margins by the Gasserian ganglia is obvious from this aspect—forming a unique arrangement for a mammal. In no other mammal have these ganglia been described as visible from the dorsal aspect of the brain. The ganglia therefore are peculiar as constituting a factor in the modelling of the roof of the cranial cavity.

The ventral surface of the natural cast (text-fig. 3) gives important confirmation of the inferences drawn already. Through this cast we are able to infer the extent and size of the huge Gasserian ganglia. With these must be related a correspondingly extensive area of grey matter in the medulla oblongata and cord (substantia gelatinosa Rolandi). The resemblance of this aspect of the casts to the ventral surface of the brain of *Ornithorhynchus* (which is the only mammal that provides a suitable comparison, by virtue of its similar functional specialisation) is undoubtedly the clue in this arrangement. Anteriorly, the ophthalmic trunk of the trigeminus overlaps the optic nerves and olfactory peduncles. The course of all three structures is parallel for some distance until the region of the tuberculum olfactorium is reached. The maxillary division of the trigeminus is there attached to the ganglion. Between the ganglion and the tuberculum the optic nerve (not visible as a distinct elevation on the surface of the cast) must have skirted the lateral aspect of the tuberculum till it reached its posterior margin, where it bent medially to meet its fellow of the opposite side in the optic chiasma, the position of which can be recognised at the posterior end of an "inter-tubercular sulcus" lying in the mid-line between the two tubercula. Directly posterior to this point there is a single median elevation present in the three casts. It is obviously the site of the strongly-marked tuber cinereum and hypophysis. Behind this region the Gasserian ganglia diverge, giving place first of all to a slight central depression, then to a broad flat surface. This wide divergence and a bulging of the cast on either side of the mid-line may be due in large measure to the forward jutting of a tuberculum quinti upon either side correlated in size with the enormous Gasserian ganglia. In the cast we have no indication that an elevation due to a pons Varolii, as such, was present, and probably it possessed no larger pons than the Prototherian. The "bulging of the cast" postero-medial to the Gasserian ganglion may therefore be interpreted as the upper portion of the tuberculum quinti. Behind it lies a transversely running depression in the region where the pons would normally lie. It is possible that this depression is due to the constricting influence of a small pons, such as was probably present. In other words, the substantia gelatinosa expanded anterior and posterior to this site to form the prominences evident in the cast. More posteriorly the base of the brain passes gradually into the medulla oblongata. In many mammals (*e. g.*, Ungulata) the transverse width of the medulla oblongata is very appreciable, but in these creatures the transverse width is never so great (relatively) as in animals (e. g., *Ornithorhynchus*) which rely to a greater extent upon the "fifth nerve sense." The great increase in transverse width found in the Zeuglodontidæ is to be regarded as a corroboration of the observation already made concerning the size of the tuberculum quinti. In the cast there is no trace of the origin of either the third, fourth, or sixth cranial nerves. The origin of the seventh and eighth is also obscure, though the latter is exposed for a portion of its course through the petrous portion of the temporal bone. The cast ends abruptly before the emergence of the IX, X, and XI complex of cranial nerves. The study of the skeletal parts

Text-figure 4.



Posterior view of natural endocranial cast of *Zeuglodon sensitivus*, sp. nov. M. 12123. About ⅓ nat. size.

confirms what has been stated concerning the splaying apart of the Gasserian ganglia (and incidentally of the posterior parts of the cerebral hemispheres and the lobi flocculares of the cerebellum) by the expansion of the tubercula quinti.

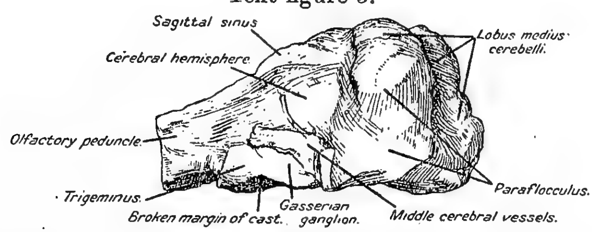
No new anatomical feature from this aspect (text-fig. 4) is revealed. The natural cast has been severed transversely at the hinder end of the cerebellum. The important fact to be remembered is that the lobus anticus and lobus posticus are probably totally hidden from external view; and the central mass of the cerebellum, as exhibited in dorsal or posterior view, is composed entirely of the lobus medius (of Elliot Smith), while laterally on either side lies the lobus flocculasis. Posteriorly to the acoustic nerve and ventrally from the lobus floccularis ("paraflocculus" of the text-figures) is to be seen an ill-defined mass, which represents the cast of the jugular vein and the associated nerve-structures, which finally emerge at the foramen lacerum posterius. I have called this region the "jugular leash."

3. *b*. Zeuglodon elliotsmithii, sp. nov. (M. 12066.)

Turning now to the lateral view of *Zeuglodon elliotsmithii*, M. 12066 (text-fig. 5), and comparing it with *Zeuglodon sensitivus* (text-fig. 1) we recognise in both the general Zeuglodont characters, which may be summarised as including a hypertrophied cerebellum tending to grow forwards over the cerebrum, hypertrophied trigeminal apparatus, and a diminutive reptilian-like cerebrum bounded by the two former behind and below, and an unusually well-marked sagittal sinus above and in the mid-line.

It will be noted that in *Zeuglodon elliotsmithii* the fore brain is very flattened and slopes upwards and backwards evenly towards the cerebellum, that the cerebellum is only slightly elevated (1–10 mm.) above the flattened cerebrum, and that appears almost vertical from the lateral aspect. In all these features this brain contrasts strongly with that of *Zeuglodon sensitivus*. Further, the trigeminal apparatus, although hypertrophic,

Text-figure 5.



Lateral view of endocranial cast of *Zeuglodon elliotsmithi*, sp. nov. M. 12066. About ⅓ nat. size.

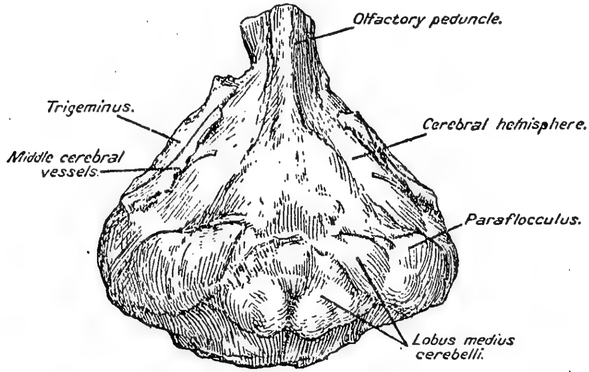
does not seem quite so pronounced as in *Zeuglodon sensitivus*, although the fragmented nature of the cast, in this region, renders a final statement upon this particular point impossible.

The features to which reference has been made are to be recognised from the dorsal aspect also. Note further from this aspect that the lobus medius cerebelli of *Zeuglodon elliotsmithii* is symmetrical, whereas the other is markedly asymmetrical (*cf.* text-fig. 2), a point which is also clearly evidenced in the posterior views (text-figs. 4 and 7).

As these figures have been drawn to scale it is clear that many features, such as the general flattening of *Zeuglodon elliotsmithii*, shown by the increased bi-parafloccular width, its general triangular outline as seen from the dorsum, and its slender transversely-elongated cerebellum mark the brain as characteristic and distinct from that of *Zeuglodon sensitivus*. These facts are brought out by a comparison of the table of brain-measurements (*vide infra*). Thus both the greater width and length of the cerebral hemispheres emphasize the flatness already referred to, while both the total length and height of the brain-mass were considerably smaller in this species.

The bulk of the endocranial cast (average of five separate measurements by water displacement) of *Zeuglodon elliotsmithii*

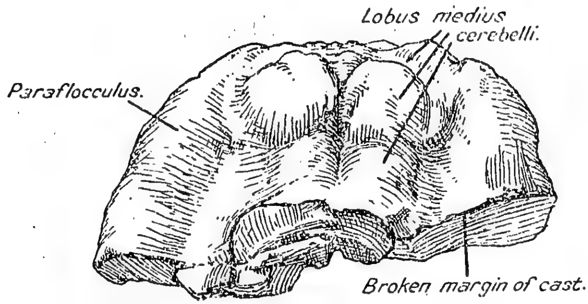
Text-figure 6.



Dorsal view of endocranial cast of *Zeuglodon elliotsmithii*. M. 12066. About $\frac{1}{3}$ nat. size.

was 300 c.c. Elliot Smith gives (1903) 410 c.c. as the bulk of this "natural cast (including that of a considerable quantity of matrix attached to the base of the brain and some small fragments of bone)," but states that the actual weight of the brain

Text-figure 7.



Posterior view of endocranial cast of *Zeuglodon elliotsmithii*. M. 12066. About $\frac{1}{2}$ nat. size.

was probably "nearer 300 grammes." In this latter estimate I am inclined to agree. But whereas the bulk of *Zeuglodon elliotsmithii* could not have been very much greater than 300 c.c., that of the natural cast of *Zeuglodon sensitivus* (in which the medulla oblongata is absent) was 490 c.c., or nearly 200 c.c. larger. This is of some interest not only in demonstrating the specific (if not generic) difference between these two Zeuglodonts but also in showing that the brain-capacity of certain Zeuglodonts was considerably greater than that of some existing Cetacea—because the brain-weight of *Kogia* (Haswell) is only 455 grammes.

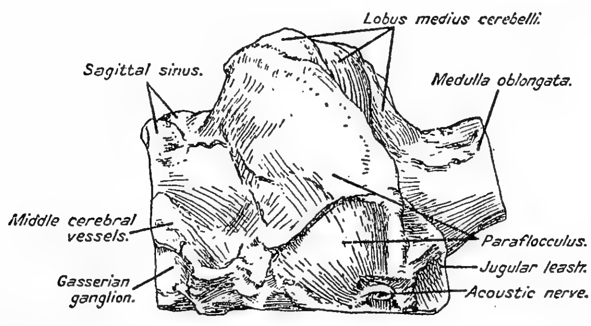
All these distinctions between these two forms are certainly not to be accounted for by a difference in the sex or age of the individuals. They should therefore be separated as distinct species, as has been done here, until fresh data shall be forthcoming when it may be possible to associate one or the other of these forms, *Zeuglodon sensitivus* or *Zeuglodon elliotsmithii*, with the species now recognised from skeletal parts alone, such as *Zeuglodon zitteli*.

4. The three Endocranial Casts forming a Phyletic Series.

4. *a*. Prozeuglodon atrox Andrews. (M. 9265.)

In the 'Descriptive Catalogue of the Tertiary Vertebrata of the Fayum of Egypt,' Dr. Andrews described briefly the outstanding features of this cast, pointing out its correspondence with Elliot Smith's general account of the Archæoceti (1903). It is unfortunate that in this important cast from the lowest bed

Text-figure 8.

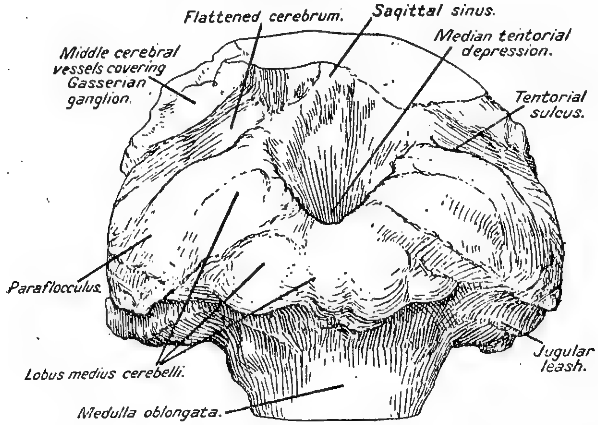


Lateral view of endocranial cast of *Prozeuglodon atrox* Andrews. M. 9265. About ⅓ nat. size.

of the Middle Eocene there is no reproduction of the anterior portion of the cranial cavity, because this region would supply important data concerning the degree of trigeminal specialisation in this early representative of the group—data which now must be inferred from the evidence afforded by other regions.

It is astonishing to find in this earliest-known Zeuglodont an extravagantly expanded cerebellum. It is the dominant portion of the brain from lateral, dorsal, or posterior aspects. It rises at certain points taken along the tentorial sulcus to a height of 35 mm. above the cerebral surface and nowhere is it less than

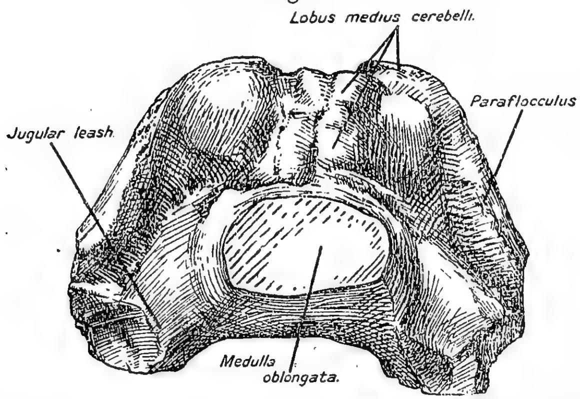
Text-figure 9.



Dorsal view of endocranial cast of 4. *a. Prozeuglodon atrox* Andrews. M. 9265. About ⅓ nat. size.

20 mm. higher than the cerebral surface. This one characteristic immediately brands this brain (however Zeuglodont in type) as something entirely distinct from what has hitherto been described

Text-figure 10.



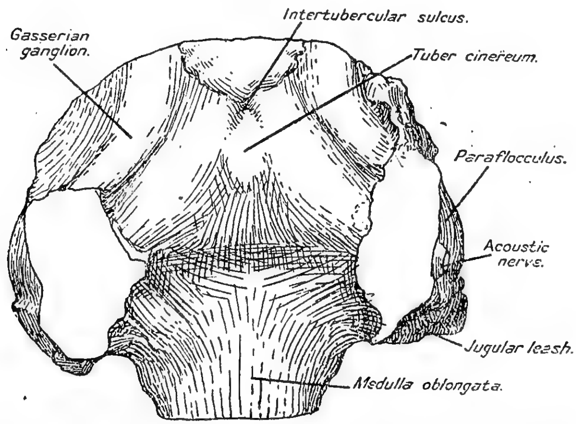
Posterior view of endocranial cast of *Prozeuglodon atrox* Andrews. M. 9265. About ⅓ nat size.

in the literature. The size of the cerebellum is immense and the size is not confined to one part of the organ only; the paraflocculus is hypertrophied, but so, too, is the lobus medius and, in addition, the latter is markedly asymmetrical.

These facts are readily appreciated from the figures. The lateral aspect is instructive as revealing the relative size of the cerebrum and the cerebellum. Coursing over the latter from the top to lateral angle is a ridge, probably indicating the site of a venous channel, which converges upon the jugular leash posterior to the acoustic nerve.

From the posterior aspect we are impressed with the vertical "lie" of the paraflocculi and their size relative to the lobus medius. The massive "jugular leash" undoubtedly accommodates the venous channels and the posterior cerebral nerves. The dimensions of the medulla oblongata should be noted for comparison with the later forms to be described.

Text-figure 11.



Ventral view of endocranial cast of *Prozeuglodon atrox* Andrews. M. 9265. About $\frac{1}{3}$ nat. size.

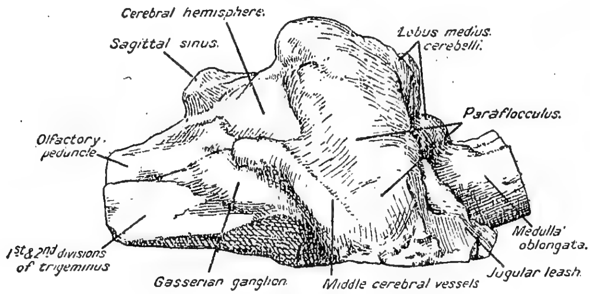
The ventral view of *Prozeuglodon atrox* should be compared with text-fig. 3. It will then be recognised that the structures on the basal surface of *Prozeuglodon atrox* are entirely comparable with those found on the basal surface of *Zeuglodon sensitivus*. It is typically Zeuglodont in character—a fact which we will find to be of great significance in comparing these endocranial casts with that of Prosqualodon. No features call for special attention at this stage of the discussion other than those noted in the figures themselves.

4. *b*. Zeuglodon intermedius, sp. nov. (M. 10173.)

Zeuglodon intermedius from the middle beds of the Middle Eocene shows from the lateral aspect features comparable in most points with those of *Prozeuglodon atrox*, save for the more marked sagittal sinus, larger Gasserian ganglia, and a greater backward thrust of the paraflocculus.

From the dorsal aspect it is evident that there is a greater

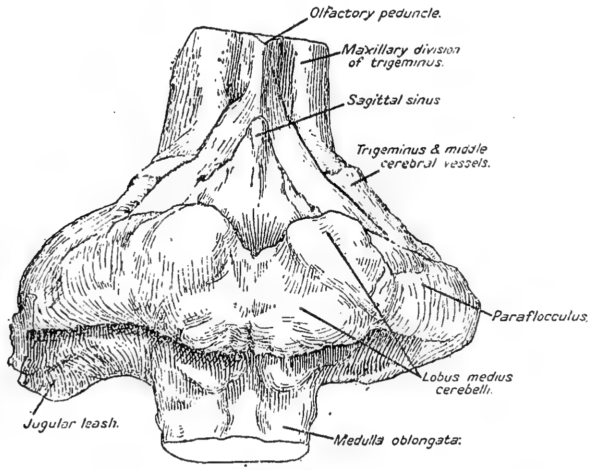
Text-figure 12.



Lateral view of endocranial cast of *Zeuglodon intermedius*, sp. nov. M. 10173. About ⅓ nat. size.

lateral thrust of the paraflocculi also, a fact still more emphasized in the posterior view. The prominence of the sagittal sinus is

Text-figure 13.

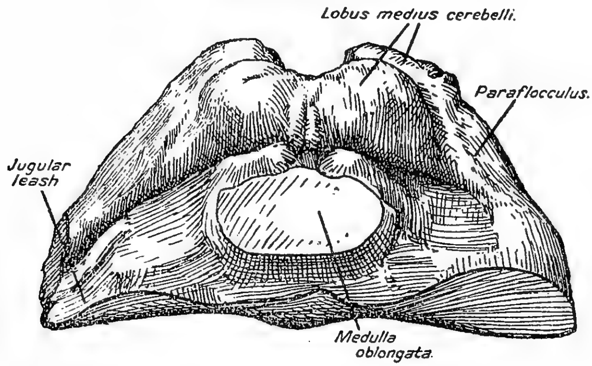


Dorsal view of endocranial cast of *Zeuglodon intermedius*, sp. nov. M. 10173. About ⅓ nat. size.

well shown from the dorsal aspect also, but the median tentorial depression is not quite so pronounced.

An arresting feature of this cast is the transversely running furrow subdividing the central mass of the cerebellum and disappearing laterally below the paraflocculi. Here it separates the paraflocculus above from the structures of the jugular leash below. It is due to a kind of secondary tentorial bony projection on the interior aspect of the occipital bone. The presence of this bony strut is perhaps to be associated with the increasing width of the occipital region. This furrow is wider and more dorso-ventrally situated in the cast of *Prozeuglodon atrox*; whereas in *Zeuglodon osiris* (vide infra) it is still transverse but very wide and scalloped out, showing that with the extreme width of the skull of *Zeuglodon osiris* the bone has become greatly reinforced in thickness internally. It is well to note such cases as these

Text-figure 14.



Posterior view of endocranial cast of *Zeuglodon intermedius*, sp. nov. M. 10173. About ½ nat. size.

where the modelling of the skull undoubtedly influences the shape of the endocranial contents, because it shows that the interplay of factors (*i. e.*, brain upon skull and skull upon brain) in cavity-modelling is ceaseless and reciprocal.

Coincident with the lateral expansion of the brain-substance there has been no widening of the medulla oblongata or the aperture of the foramen magnum (*vide* Tables), but the thickness of the medulla oblongata has decreased somewhat and so it presents a somewhat more ellipsoidal transverse section.

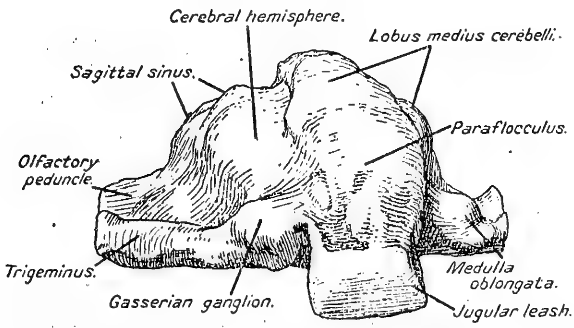
The cubical capacities of these two casts was 790 c.c. for *Prozeuglodon atrox* and 785 c.c. for *Zeuglodon intermedius*. As the cast of *Prozeuglodon atrox* was very incomplete anteriorly it is evident that its cubic bulk must have been considerably over 800 c.c.

The degree of likeness between these two forms both cranially and endocranially is so great that they may be regarded as very closely related phyletically. Because of this the decreased volume of the brain of *Zeuglodon intermedius*, in accordance with the "law of increasing brain weight" expressed by Marsh, indicates a degenerating condition in this later Zeuglodont type. When we realise that *pari passu* with this decrease in volume there is an actual increase in the lateral thrusting of the brain-mass and with it of the Gasserian ganglia, and a relative flattening of the mass of medulla oblongata, it seems clear that this degeneration is primarily trigeminal in nature.

4. *c.* Zeuglodon osiris Dames. (M. 10228.)

A comparison of the lateral aspect of the cast of *Zeuglodon osiris* from the upper beds of the Middle Eocene with the preceding forms is very striking. One gathers the impression that the brain-mass is shrivelled and shrunken, a conception that is strengthened by examination of the dorsal and posterior views. If we take the features seriatim we find first of all that the Gasserian ganglion is relatively small as compared with the other forms, but its stranded position (laterally to the cerebrum—see dorsal view) shows that this creature is descended from a type in

Text-figure 15.



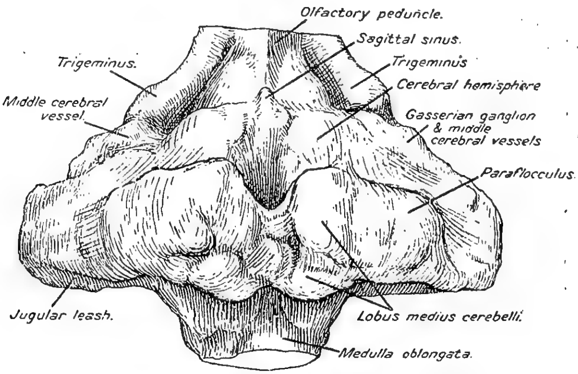
Lateral view of endocranial cast of *Zeuglodon osiris* Dames. M. 10228. About $\frac{1}{3}$ nat. size.

which the trigeminal apparatus was of a much more imposing nature. The "gouged out" cerebrum reveals a degenerate condition of this organ. Obviously the olfactory region has become even more atrophied than in the other known Zeuglodonts. Despite the opportunity offered by this atrophy anteriorly and the diminished size of the cerebellum posteriorly the cerebrum is diminutive.

The cerebellum is still large but it is crumpled. The paraflocculi no longer bulge over the acoustic region, but are contracted towards the lobus medius. The latter is very asymmetrical. The space between the middle cerebral vessels and the jugular leash, and lateral to the paraflocculus, seems to have been devoid of brain-substance in the recent condition and to have been occupied by venous sinuses.

The lobus medius, or area crescens, is not only very asymmetrical but is poorly developed, and the paraflocculi form by far the greatest part of the cerebellar mass. The posterior view affords perhaps the completest picture of this atrophic brain, for here we recognise the general flattening out or "cake-like" appearance of

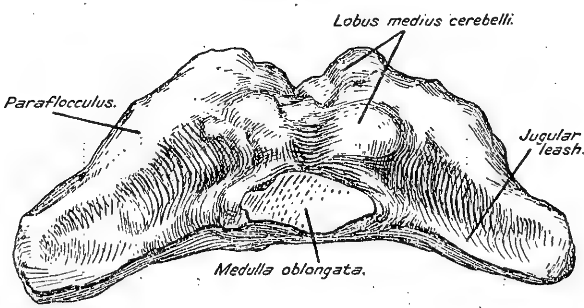
Text-figure 16.



Dorsal view of endocranial cast of *Zeuglodon osiris* Dames. M. 10228. About $\frac{1}{3}$ nat. size.

this brain (which came from a perfect skull) and also the extremely long but narrow cross-section of the medulla oblongata. This view of the medulla oblongata coupled with the lateral view

Text-figure 17.



Posterior view of endocranial cast of *Zeuglodon osiris* Dames. M. 10228. About $\frac{1}{3}$ nat. size.

of this region corroborate the inference we have already drawn that in *Zeuglodon osiris* we have the *degenerate offspring of a specialised race.*

The degree of this degeneration is perhaps most graphically shown if we compare the cubic capacity of this brain (480 c.c.)

5. TABLE OF MEASUREMENTS OF THE ENDOCRANIAL CASTS.

	M. 12123. *Z. sensitivus.*	M. 12066. *Z. elliotsmithi.*	M. 10228. *Z. osiris.*	M. 10173. *Z. intermedius.*	M. 9266. *Proz. atrox.*
Greatest width of cerebrum	87 mm.	92 mm.	94 mm. (approx.).	90 mm. (approx.).	95 mm. (approx.).
Greatest inter-parafloccular width	135 mm.	126 mm.	192 mm.	172 mm.	153 mm.
Length of cerebral hemisphere (measured to the tentorial sulcus)	56 mm.	64 mm.	52 mm.	47 mm.	42 mm. (approx.).
Height of cerebellar projection above the cerebrum along tentorial sulcus	10–20 mm.	1–10 mm.	15–20 mm.	20–25 mm.	20–35 mm.
Width of middle lobe of the cerebellum ... *a.* in the region of the Area B	91 mm.	100 mm.	60 mm. (approx.).	96 mm.	114 mm.
Width of middle lobe of the cerebellum ... *b.* in the region of the Area C	65 mm.	53 mm.	57 mm.	64 mm.	47 mm.
Width of medulla oblongata at foramen magnum	—	—	40 mm.	57 mm.	58 mm.
Height of medulla oblongata at foramen magnum	—	—	20 mm.	34 mm.	37 mm.
Greatest height of brain-mass from base to lobus medius cerebelli	73 mm.	66 mm.	65 mm.	96 mm.	96 mm.
Greatest antero-posterior diameter of cerebellum measured midway along tentorial sulcus	30 mm.	28 mm.	41 mm.	43 mm.	50 mm.
Greatest length of brain-mass	100 mm. (approx.).	97 mm. (approx.).	100 mm. (approx.).	108 mm.	110 mm. (approx.).
Cubic capacity	490 c.c.	310 c.c.	480 c.c.	785 c.c.	800+ c.c.

with those of the foregoing which are almost twice the size. An examination of the tables and the diagrams of the skulls will show that this discrepancy in brain-capacity is not due to any diminished bodily size in *Zeuglodon osiris*, for although the skull may be somewhat shorter it is absolutely wider than those of the other two forms.

One can only conclude that we have here an obvious dwindling in brain-substance which has affected not only the trigeminal and olfactory regions but with them the cerebrum, cerebellum, and the medulla oblongata. The whole evidence goes to show that the devolutional potentialities exhibited in the specialisations (chiefly trigeminal) of *Prozeuglodon* and the group it typifies have found in *Zeuglodon osiris* (M. 10228) their logical finale.

6. The Zoological Position of the Zeuglodontidæ.

Certain facts arising from our study of these endocranial casts claim our immediate attention. The first of these is the trigeminal specialisation. In all of the Zeuglodonts (although coming from different horizons) the essential features noted in *Zeuglodon sensitivus* apply. In all, the Gasserian ganglion assists in modelling the roof of the cranial cavity. The inference is justified that the group, as a whole, rested from the outset upon this specialisation for its subsequent achievements.

It seems to be a law of general evolutionary application that specialisation of one "sense" entails as its corollary the atrophy of one or more of the other avenues of sense-perception. Thus, birds become specialised as to sight but lose their appreciation of smell; the same is true, though in different ways, for Teleostean fishes and for Primates. In *Ornithorhynchus*, which specialises in its "fifth nerve sense," we find a relative atrophy of both smell and sight. In Zeuglodontidæ the sense of smell has certainly been largely lost as a result of their adoption of a water habitat, and it seems likely that sight also was of diminished value.

To the loss of smell and the abortion of the basal (olfactory) parts of the cerebrum with their effect in limiting the longitudinal extension of the hemispheres and consequently of the cranial cavity, reference was made by Elliot Smith (1902 and 1903). A relative loss of sight, with a resulting diminution of the mid-brain and thalamic regions, may assist in accounting for the smallness of the cerebrum in *Prozeuglodon* and also for its lack of growth in the two later forms from the upper horizons. It assists in the understanding of the propinquity of the cerebellum to—or, rather, its overgrowth over—the cerebrum, and affords further reason for the diminished longitudinal extension of the cerebral axis (because of a wasting mesencephalon and optic thalamus and the consequences entailed thereby) throughout the series.

But it seems to me that the lateral expansion not merely of the brain-stem itself but also of the cerebellum has been provoked mainly by the trigeminus, and that a specialisation of this nerve has been the most significant factor in determining the queer contour of the Zeuglodont brain. Of course, the enlarged cerebellum has played a role in the lateral expansion of the cranial cavity, but the extraordinary dimensions, even for an Eocene animal, of this cerebellum can only be explained by the tribute coming from trigeminal nerves whose Gasserian ganglia rival the cerebral cortex in size. Hence the influence of the cerebellum is fundamentally trigeminal in origin.

It is true then that, although the trigeminus has played the chief part in this expansion, the internal factors include also an olfactory and a visual factor and may well have been assisted in Zeuglodonts, as Andrews (1908) suggested, by the "pressure on the anterior end, more or less in the direction of the long axis," during motion through the water, "and during very rapid movement this pressure must be considerable."

Now a reduction in value of the sense of smell and possibly of sight and a compensatory dependence upon the sense of touch in the muzzle—*i. e.*, a certain degree of trigeminal specialisation—are equally to be anticipated in the ancestors of modern Cetacea. Might it not be that the Zeuglodontidæ, in this respect as in their osteological conformity, are to be regarded as ancestral to Cetacea? This might be admitted if it were not for the demonstration of the already-marked specialisation of *Prozeuglodon atrox* and the gradual deterioration by specialisation within the phyletic series as already discussed. In this light the passage of Cetacean ancestors through a "trigeminal" stage in evolution can only be cited as convergence, or may be explained by the hypothesis that the Zeuglodontidæ and the true ancestors of Cetacea may have had a common ancestry in the earliest Eocene.

Despite the positive views concerning the ancestral relationship of Zeuglodontidæ to Cetacea stated at the outset, it must not be assumed that palæontologists are agreed concerning this interpretation.

As early as 1877 Marsh said: "That the connection (between *Zeuglodon* and Cetacea) was a direct one, however, is hardly probable, since the diminutive brain, large number of simple teeth, and reduced limbs in the whales all indicate them to be an old type which doubtless branched off from the more primitive stock leading to the Carnivores."

Weber (1886, p. 243) also referred to *Zeuglodon* as "einen verunglückten Versuch Cetaceen herauszubilden," and although there have been wavering opinions by many since, which even Weber himself has shared, many, such as Müller, Fraas, and Stromer, have enunciated the same view.

Fraas, in 1905, summed up the evidence to that date available and showed that the Zeuglodontidæ, arising from some possible Creodont stock, have passed through some stage corresponding to his *Eocetus* (*Mesocetus*) and, by differentiation, have produced various forms, including the gigantic ones which generally have marked the acme of evolutionary progress in many groups of animals, after which the race has disappeared. He has felt it impossible to regard such later gigantic forms as ancestral to the later Squalodon series of animals, which appear to be more definitely related to the progenitors of the modern Cetacea. According to Winge (1919, 1921) Fraas "considered both *Protocetus* and with it other Zeuglodonts as a side branch from the Carnivores which did not lead in the direction of true whales."

Stromer (1908, p. 174) also states: "Ich halte also einstweilen für geboten die Zeuglodontidæ für eine ähnliche Parallelreihe der Denticeten anzusehen, wie sie neuerdings innerhalb vieler engeren Säugethier-abtheilungen nochgewiesen wurden. Sie hatten schon im Obereözan ihre Blütezeit unter Entwickelung von Riesenformen wahrend die anderen fast gleichartig aber viel weiter sich differenzierend langsamer sich entwickelten und wieder in mehrere Zweige auseinandergingen, die auch in vieler Beziehung einander parallel fortliefen. In diesem Sinne also nehme ich wie Weber (1886, S. 243) Zeuglodon als 'einen verunglückten Versuch Cetaceen herauszubilden' halte aber für noch nicht beweisen dass alle Archæoceti so auf zufassen wären."

Abel, in his later works (1913), does not appear to have any doubt that the Zeuglodontidæ lie off the direct line, with the possible exception of the so-called Microzeuglodontidæ. Because of their great specialisation, the degree of which would entirely unfit them for such an evolution, I am entirely in agreement with the opinion that no Zeuglodont here examined can be regarded as ancestral to Cetacea.

It is a curious fact that these highly specialised animals have so wide a geological distribution, and one in favour of their marine life. This wide distribution may have occurred before the trigeminal specialisation, so characteristic of all these Fayum forms, was attained. This makes the examination of the endocranial casts in Zeuglodontidæ found elsewhere in Europe, in America, and in Australia of the greatest importance because the facts put forward demonstrate our lack of knowledge concerning the evolutionary history of the whales and also because "the distribution of the Zeuglodontidæ and other shallow-water fauna" has been used (Stromer, 1906, and Andrews, 1907) to indicate the location of the shore-lines of previous land-connections between the Old and New Worlds. I consider that in the demonstration of this tactile specialisation in Zeuglodonts their restriction to a shore-line distribution is shown to be highly probable.

The parallel origin of the Zeuglodontidæ and the Sirenia—probably in the Lower Eocene—is very striking. The grade of cerebral organisation in both is approximately similar, but the cerebellum of Zeuglodontidæ seems to indicate that its life was somewhat less retired than that of Sirenia. Andrews (1907) has shown that "freedom from competition and, to some extent, from powerful enemies, would offer exceedingly favourable conditions for the rapid spread and multiplication" of these groups in the Eocene seas. Thus both groups became widely disseminated, but whereas the Sirenia have persisted as "living fossils," despite their humble grade of intelligence, the Zeuglodontidæ have long since disappeared.

This disappearance is to be correlated with the fact that, whereas the Sirenia chose an eminently retired and sluggish mode of existence, the Zeuglodontidæ were more active. They came into more direct conflict with other marine forms and, specialised as they were, did so at a disadvantage and were overwhelmed in the struggle for existence.

The present study therefore indicates that the scepticism of Marsh and Fraas was entirely justified and that Winge (1921) is incorrect in regarding the Zeuglodontidæ as ancestral to Cetacea. The origin, dispersal (into so many strikingly different forms and all over the globe), and disappearance of this group geologically is a demonstration of the conception put forward by Marsh (1877) that "In every primitive type which was destined to survive many geological changes there seems to have been a tendency to throw off lateral branches which become highly specialised, and soon die out, because they are unable to adapt themselves to new conditions."

7. Comparison of Zeuglodont and Prosqualodont Brains.

The above paper was practically ready for the press when Prof. Elliot Smith received from Tasmania, through the great courtesy of Prof. Flynn of the Zoological Department in the University at Hobart, a splendid cast of the cranial cavity of *Prosqualodon davidi* which he has recently described. Plaster replicas of the skull from which this cast was made were presented by him to the British Museum of Natural History and to the Zoological Department of University College, London. I have had the privilege of studying these casts and the endocranial cast.

The lateral view of this cast (text-fig. 18) reveals an astounding likeness to the Zeuglodont endocranial cast. We meet with the same cerebellar enlargement, expanding forwards over the cerebrum, and quite an enlarged trigeminus.

It is obvious that such striking similarities would not exist in the absence of some close relationship between these forms, but the data will reveal that this relationship is not a filial one as it has frequently been conceived.

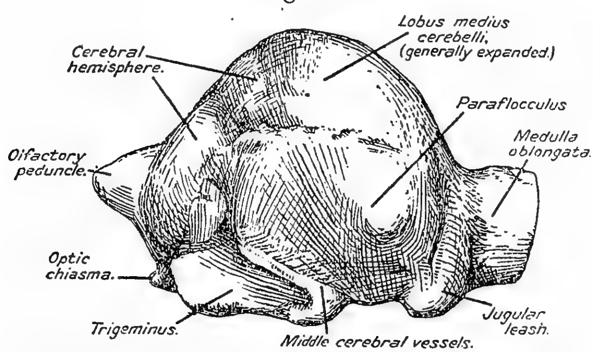
It is to be noted that the paraflocculus is recognizable laterally, but is submerged by a widely and generally expanded cerebellum. The cerebrum is emancipating itself from the cerebellar growth as its great height posteriorly shows. Anteriorly the rapidly dwindling olfactory apparatus is attached in a "nipple-like" fashion to the cerebrum and considerably ventral to it is a well-marked optic chiasma. The middle cerebral vessels reveal a course comparable with that seen in the Zeuglodonts and posteriorly there is a well-marked jugular leash.

The dorsal view corroborates what we have already detected from the lateral aspect. The wide expanse of the "area crescens" cerebelli is the most obtrusive feature and after that the expanding cerebrum. The double olfactory peduncle is clearly seen but no Gasserian ganglion is visible (text-fig. 19).

The posterior view is instructive in revealing an enlarged oval transverse section of the medulla oblongata and still further illustrates the nature of the cerebellar expansion (text-fig. 20).

Perhaps the most informative of all is the ventral view, because we are able to recognise the true size of the trigeminus (which is quite large), the relatively enormous width of the base of the brain, the marked development of the optic chiasma, and the relative atrophy of the olfactory apparatus. There is an entire absence in this brain of anything corresponding to the tuberculum olfactorium or "intertubercular sulcus" of the Zeuglodonts, but we find a ridge on either side of the middle line medial

Text-figure 18.



Lateral view of endocranial cast of *Prosqualodon davidi* Flynn. About ⅓ nat. size.

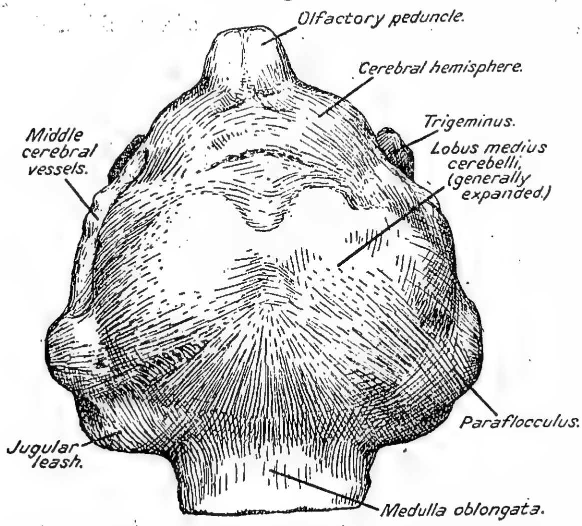
to the trigeminal region which may be due to the carotid artery and accompanying venous sinuses. The tuber cinereum is not apparent in the cast, but must lie between these ridges (text-fig. 21).

Prosqualodon davidi Flynn comes from the Miocene deposits of Tasmania, and the characters which it presents linking it to the Zeuglodonts might well be interpreted as illustrating its origin from the Zeuglodont family if our information were not so complete as it is now.

The actual bulk of this endocranial cast is approximately 750 c.c., *i.e.*, not quite so great as that of *Zeuglodon intermedius*. This fact itself is sufficient to show that the Eocene form which gave rise to *Prosqualodon* must have possessed a brain-capacity very much less than that of *Prozeuglodon atrox* or of *Zeuglodon intermedius*. This follows from the well-known "law of increasing brain weight" put forward by Marsh and supported by all palæontological endocranial investigation up to the present time.

Quite apart from this there is ample evidence against the view that a Zeuglodont, even one so primitive as *Prozeuglodon*, could have given rise to *Prosqualodon*. This is very evident if we call to mind those features pointed out in detail for *Zeuglodon sensitivus* (*vide* text-fig. 3) and repeated by all the Zeuglodonts. It was shown in that case that the site of the insertion of the olfactory peduncle in the Zeuglodonts had been drawn, as it were, during atrophy under the fore brain on to the basal aspect. This contraction of the area between the olfactory peduncles and the tuber cinereum demonstrated for us the relative atrophy of the

Text-figure 19.



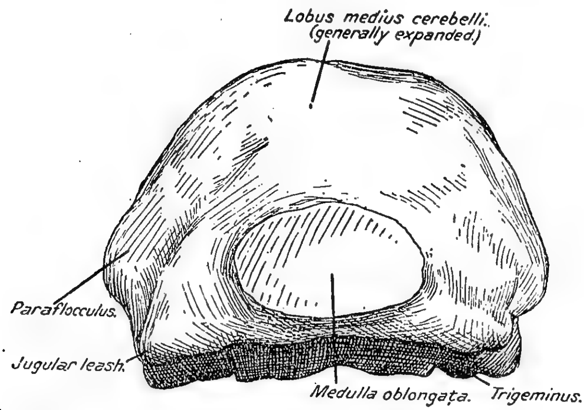
Dorsal view of endocranial cast of *Prosqualodon davidi* Flynn. About ½ nat. size.

optic chiasmatic region in Zeuglodonts, and, fortunately, the cast of *Prozeuglodon atrox* in this crucial region is sufficiently perfect to illustrate the fact that these changes were already well marked in the Zeuglodonts of the earliest Middle Eocene deposits of the Fayum (*vide* text-fig. 11).

In the case of *Prosqualodon davidi*, on the other hand, we find that the course of its evolution has been entirely different. There is evidence here of an initial expanding of this basal area between the insertion of the olfactory peduncle (*vide* text-fig. 21) and the tuber cinereum (which lies somewhere between the "carotid ridges"). Crossing this wide interspace in *Prosqualodon davidi* we find in the well-defined optic chiasma the evidence of the retention of elaborate visual capacities in the Miocene—an utter impossibility in the offspring of the Zeuglodonts here described at any epoch.

It is of some value to appreciate how great a degree of trigeminal specialisation is compatible with future evolution. For it is evident that *Prosqualodon davidi* has an enlarged trigeminus, even though we do not find such gross enlargement of the Gasserian ganglia as in the Zeuglodonts. It has already been indicated that "a certain degree of trigeminal specialisation" is to be expected in the ancestors of Cetacea. It seems unquestionable that the initial widening of the Prosqualodont, as well as that of the Zeuglodont, brain and medulla oblongata is due not merely to the passive recession of the sense of smell but rather to the active hypertrophy of the trigeminal apparatus, which in an aquatic mammal provides so much more information

Text-figure 20.



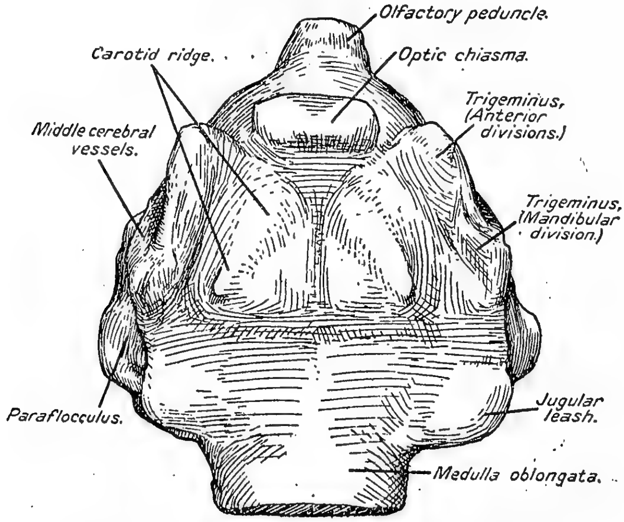
Posterior view of endocranial cast of *Prosqualodon davidi* Flynn. About ⅓ nat. size.

concerning food, friends, and foes than do the senses of smell or sight.

Prosqualodon davidi teaches us therefore that the evolution of the Cetacean stock, while it depended to some degree upon an initial trigeminal specialisation, was not effected by any sudden reliance upon this sense to the neglect of other important senses, but depended upon an orderly and "balanced" correlation of this hypertrophy with a concurrent aggrandisement of the visual and auditory senses. In this connection it is significant that the most expanded portions of the fore brain in *Prosqualodon davidi* appear to be the "occipital" and "temporal" regions; *i. e.*, posteriorly and laterally, where one may reasonably conclude that these senses were finding cerebral representation. Whether Fraas is correct in believing that even the more primitive *Protocetus* is also off the main line of Cetacean evolution would probably be indicated by an examination of the endocranial casts with regard to these details.

The conformation of the district between the olfactory peduncles and the chiasma—in fact, the whole "mamma-like" appearance of the antero-ventral portion of the fore brain in *Prosqualodon davidi*, contrasting as it does with the same region in the Zeuglodonts—is consonant with the homologous region in true Cetacea. A comparison of this region with the ventral aspect of the brain in the fœtal *Monodon* or adult *Kogia* (*vide* figures in Elliot Smith's account, 1903) demonstrates the truth of the conception that the ancestors of true Cetacea went through

Text-figure 21.



Ventral view of endocranial cast of *Prosqualodon davidi* Flynn. About $\frac{1}{3}$ nat. size.

a stage of "expansion of the basal regions of the brain" (witness the "desert region" of Broca in Cetacea) not displayed by Zeuglodonts but evident enough in *Prosqualodon*.

What this expanded "desert region" or tuberculum olfactorium in whales exactly signifies, we are not as yet able to definitely state. Since this area is the site of the palæostriatal cortex overlying the palæostriatum (Dart, 1920) it follows that the persistence of a large "desert region" is dependent on factors other than olfactory, *i. e.*, factors which have determined the size of the palæostriatum itself. The consideration of what these factors actually may be lies outside the scope of this article, but the essential point affecting our argument here is that these factors, whatever their nature, played an enhanced rôle in the ancestors of Cetacea, whereas they were recessive and negligible in the Zeuglodontidæ.

The evidence afforded by this cast therefore supports the conclusions which we drew in the earlier part of this paper concerning the deflection of the Zeuglodont line from the course of true Cetacean evolution, but supports the conception that *Squalodon* has at least close affinities with the true Cetacean stock.

8. The Trigeminus and the Law of Infiltration in Cerebellar Evolution.

In conclusion, it is necessary to call to mind certain general facts about the cerebellum which appear to throw light upon the strange and generalised hypertrophy of that organ in this group.

We know that animals with very sensitive whiskers and bristles (such as certain Rodentia) depend largely for their power of equilibration upon stimuli which arise in nerve-endings situated in relation with the proximal end of these whisker-like structures and affected by their faintest movement. Such stimuli are communicated to the cerebellum by way of the trigeminus. In *Ornithorhynchus*, instead of bristles, there is a remarkable development of special receptive end organs in the delicate snout served by the trigeminus. The bristles round the mouth-parts of the Sirenia may be active in a similar way in addition to their function as tactile end organs.

The more recent researches of Ingvar (1918) have placed the morphological survey of the cerebellum by Elliot Smith upon an even firmer basis: for he has extended his research into the Reptilian and Avian series and has shown that here, too, the same sulci and three lobes are distinguishable. Such a division into three lobes does not appear to obtain in Fishes or Amphibia. It seems therefore that the advent of the middle lobe synchronises with the origin of a neopallium in the cerebral cortex. The researches of Haller (1900), of Unger (1906), and of Crosby (1917) have shown that the first clearly defined neopallium primordium makes its appearance in the Reptilia, and in these creatures the tripartite structure of the cerebellum is also clearly to be recognised for the first time.

Recognising the relationship which the development of the neopallium has to the expansion of the cerebellum in Mammalia it is, at first, most disconcerting to find in a group of Eocene mammals with such ill-developed neopallium a cerebellum of extravagant proportions which has not merely obliterated all traces of the mid-brain from the surface but threatens to cover the cerebrum also by its forward expansion.

The cerebellum is usually relatively large in Eocene mammals and yet such a bizarre arrangement as is present in Zeuglodonts can have only one explanation. We may eliminate the neopallium as an explanation because of its slight development and the doubtful presence of a pons Varolii, and it is equally unlikely that the spino-cerebellar contribution could have been so great as to account for the whole of the cerebellar expansion. But we do know that so diminutive and primitive a mammal as *Ornithorhynchus*, with a well-developed trigeminal apparatus can and does possess not only an unexpectedly large neopallium, but also a relatively large convoluted cerebellum. The absolute and the relative size of the Gasserian ganglia in *Zeuglodon sensitivus*, and indeed in all Zeuglodontidæ here represented, are far more striking than they are in *Ornithorhynchus*. There can be no doubt that the afferent impulses reaching the cerebellum from the anterior end of the body in Zeuglodontidæ were of particular value in supplying these animals with information concerning disturbances of equilibration. The distribution of the trigeminal tract within the cerebellum is not fully known, but it is believed by many investigators that in Mammalia there is a tract for conveying trigeminal impulses to the cerebellum. The huge cerebellum in the Zeuglodontidæ may well be due to the fact that, by a rapid and hypertrophic development, the trigeminus provided it with very precise information concerning its position in space and hence afforded to this primitive creature a ready solution of the problem of equilibration in a fluid medium.

I have said that the distribution of a direct trigeminal tract within the cerebellum is not fully known; it would be nearer the truth to state that it is frequently affirmed but is sometimes denied. Since such denial exists it is valuable to put forward other supporting evidence. It seems to me that the denial of the existence of a direct trigeminal connection with the cerebellum can only come from an imperfect appreciation of the developmental history of the cerebellum and a consequent failure to recognise its extent in the brain-axis—or else from a tendency, very manifest during the last two decades, to regard the cerebellum as an overgrown part of the vestibular apparatus.

As regards the development of the cerebellum it must be remembered that the cerebellar ridge first appears in early embryos much further forward in the hind brain (metencephalon) than would be anticipated on the "vestibular" hypothesis. Even in human developmental history, the nerve which is more obviously associated with the cerebellum is the trigeminal and not the vestibular. Ingvar (1918) finds that "Die Basis (cerebelli) ist frontalwärts gerichtet. Von dem ventralen Rande dieser Basis laufen die kräftig entwickelten N. N. Trigemini aus"; or (on p. 343) "Ventralwärts grenzen die Cerebellarwülste an die Insertionstelle des Trigeminus."

It is not absolutely certain what actual neuromere of the hind brain gives rise to the cerebellum, nor is that question pertinent to the present discussion. The embryological facts significant here are: (1) that the cerebellum arises in the most anterior portion of the hind-brain roof, and (2) that the territory of the neural tube in this vicinity is associated in the vertebrate embryo with the trigeminus (*cf.* Wilson and Hill, 1902; Streeter, 1908), while the acoustico-facialis mass lies entirely posterior to the trigeminus and is related to a different territory which lies medial to it. Hence, any encroachment of vestibular fibres from its territory of the neural tube into the territory which is related to the trigeminus is a secondary phenomenon whether considered phylogenetically or ontogenetically, even though such fibres be direct fibres. In other words, the appearance of vestibular fibres in the cerebellar region is an intrusion just as certainly as is the appearance of the mesencephalic fibres of the trigeminal in the mid-brain, or of thalamic fibres in the fore brain.

The simplest cerebella reproduce more or less faithfully this condition characteristic of the embryos of all Vertebrates. They are mere ridges roofing the most anterior portion of the fourth ventricle and are consequently a link between trigeminal territories and contain decussations of the trochlear and trigeminal nerves (Herrick, 1914; Larsell, 1920; Palmgren, 1921).

In the simplest cerebella *intrusions* of alien fibres are already found, even as we find alien fibres in the simplest-known fore brain and tectum opticum. These *intrusions* occur in the cerebellum in such a way that just as we find the olfactory apparatus is relegated to the periphery of the fore brain and the optic fibres to the periphery of the mid-brain, so we find that the trigeminal territory forms the true fringe of the cerebellum. Consequently, Beccari, Ingvar, and others (Kappers, 1921) have found a direct distribution of the trigeminus to the cerebellum (*e. g.*, in Reptilia).

Topographically, the contribution of the vestibular nerve to the cerebellum is always surrounded by the trigeminal territory and the fibres proceeding to the cerebellum therefrom. Ingvar (1918) has shown (in Mammalia) a distribution of the vestibular component mainly in the flocculus, lingula, and nodulus, and thus *peripherally* to the still more recent intrusions of spino-cerebellar contributions. On the other hand, spino- and olivo-cerebellar fibres have not been demonstrated in such peripherally lying parts such as the lobus floccularis, and it is to be noted (*vide* Kappers, 1921) that this region is not dependent upon a cerebro-pontine contribution; whereas the clinical researches of Winkler have corroborated the conception that the latest portions of the cerebellum in the phylogenetic sense are more centrally situated.

This "laminar" arrangement of the cerebellar constitution, as it might be termed, although not so clearly defined as the somewhat similar arrangement of successive fibre-intrusions into the fore brain, is nevertheless present. It is to be expected also from the fact that those tracts, which later in phylogeny become incorporated with any region, attain this incorporation by *infiltration* and a spreading apart of the pre-existing mechanism.

The arrangement may be expressed by stating that the vestibular, olivary, spinal, and cerebro-pontine contributions successively come to reach the cerebellum by penetrating a territory which was originally, and so ancestrally, trigeminal.

As has been suggested already, this phenomenon of "penetration" may be illustrated equally well by the *infiltrations* of the mid-brain, thalamus, or fore brain, or by the *infiltration* of the hippocampal commissure by the corpus callosum in the fore brain of Mammalia as shown by Elliot Smith. In brief, if we accept the doctrine of the segmental arrangement of the neural tube elements, it is to be anticipated that the principle finds illustration in the development of the majority of the inter-segmental and supra-segmental apparatuses.

The language of neurology is devoid of any term which describes conveniently this uniformity of behaviour in the laying-down of subsequent formations in the neural tube. It should prove of service therefore to descriptive neurology to recognise in this uniformity the consistent working of a general principle which underlies the whole architecture of the brain and which we may term for convenience the *Law of Infiltration.*

By an inverse reasoning, if this law is correctly conceived, a *peripheral* or *fringing* arrangement of the trigeminal territory itself, and of fibres known to proceed to the cerebellum from it, corroborates the identification of the trigeminal apparatus with the cerebellum and the function of equilibrium, more primitively even than the vestibular apparatus.

These matters have been neglected by those who assert that the auricle of the cerebellum, or lobus flocculāris (Kappers, 1921), is the *oldest* part of the cerebellum. It is not the auricle, but the anterior medullary velum which would better deserve this appellation. The "vestibular" hypothesis has been attractive because it has seemed to demonstrate the fact that the cerebellum was "equilibratory" from the beginning. But this hypothesis tends to ignore the equilibratory potential of all tactile sense, it fails to account for the existence of a cerebellum (Cyclostomes) which has no auricle, and does not account in any way for the striking relationship which the trigeminal nerve always has to the cerebellum in all Vertebrata.

The fifth nerve displays a relationship to that segment of the neural tube, in which the cerebellum becomes developed, which is paralleled only by the relationship of the olfactory nerve to that segment of the tube in which the prosencephalon, and of the optic nerve to that segment in which the mesencephalon is developed. The oldest part of the organ is the trigeminal territory itself just as the olfactory sensorium was the oldest representative of a fore brain and the visual sensorium of a mid-brain.

I have discovered that Spitzka (1886) put forward a somewhat similar view concerning the cerebellum nearly forty years ago :— "I am inclined to consider it as a homologue of the gelatinous nucleus of the fifth pair, and as in a primitive relation with that nerve; that subsequently the auditory nerve entered into connection with it, and that, increasing in dimension with its increasing neural connections, it attained the high development found in the human cerebellum through the spinal and cerebral tracts that are detached into its medullary substance." Therefore the present statement of this relationship, although more detailed, cannot be regarded as a novelty.

If we consider the nature of the influences at work in the production of the early chordate brain, it is evident that the more anterior segments were concerned in the production of the olfactory and visual specialisations. These specialisations were bought at the price of successive anterior segments of the primitive vertebrate skin and neural tube. When these anterior segments lost by their specialisation the capacity for the appreciation of *pressure*, the succeeding segment which retained this power grew forward invading the territory of the more specialised segments lying anterior to it. Such an invasion meant an increase or hypertrophy of this (trigeminal) segment and a specialisation within it of the *tactile* function. How exuberant has been its response to this demand is demonstrated by the fact that—amongst Mammalia, for instance—it subserves the tactile sense for the entire region anterior to the second cervical nerve, with the exception of the vestigial somatic elements of the vagus (Arnold's nerve).

The information conveyed by the trigeminal system proved extremely valuable, because it told the animal so much about what moved in space around it and also *about its own position in space*. Hence the central processes from the trigeminal ganglion assumed a sudden reflex ascendency over an increasing number of the succeeding segmental nerves through the radix descendens and the substantia gelatinosa Rolandi in most Vertebrata. Even in Man the descending root of the trigeminal represents one of the most impressive features of the medulla oblongata. Always a striking feature in Mammalia, this reflex dominance is shown to its best advantage (in living forms) in *Ornithorhynchus*; in this creature the trigeminal seems to exert a reflex control over practically the whole of the spinal cord.

Thus there has been a downward encroachment of the trigeminus upon lower segments of the medulla oblongata in a fashion comparable with the upward encroachment of the vestibular nerve into the trigeminal territory or of the mesencephalic root of the trigeminal upon optic territory. It is a further example of the *Law of Infiltration*. Seemingly this encroachment afforded the bridge whereby the spino-cerebellar systems were conducted to the originally trigeminal territory of the cerebellum. For the spinal fibres naturally lay *peripheral* to the infiltrating descending root of the trigeminus, and as the spinal fibres coursed towards the cerebellum they came to embrace the trigeminus trunk before piercing its territory to enter the cerebellum. The differentiation into anterior and posterior spino-cerebellar tracts emerged from a relationship primarily not to the cerebellum as such, but to the trigeminus.

So, in addition to the *fringing* above mentioned, a graphic picture of the central role which the trigeminal has played in the origin of the cerebellum is afforded by the relation of the anterior and posterior spino-cerebellar tracts to the trigeminal nerve (in most Vertebrata) and by the central position of the trigeminus in the pons (in higher Mammalia).

Considering the nature of the impulses it conveyed, it is not surprising that the trigeminal nerve, which has had such diverse evolutionary possibilities in all vertebrate groups, should have been very intimately concerned in the emergence and evolution of the cerebellum in Vertebrata. Nor is it surprising that we should find illustrated in the Zeuglodontidæ a group of primitive mammals taking to a water life at a stage so plastic that the trigeminal apparatus should become sufficiently specialised and hypertrophic to determine, through its moulding of the cerebellum and the spinal cord, the whole course of evolution (or devolution) of its central nervous system.

9. Note on the Skulls from which the Endocranial Casts described by Dr. Dart were taken. By C. W. Andrews, D.Sc., F.R.S. (British Museum of Natural History.)

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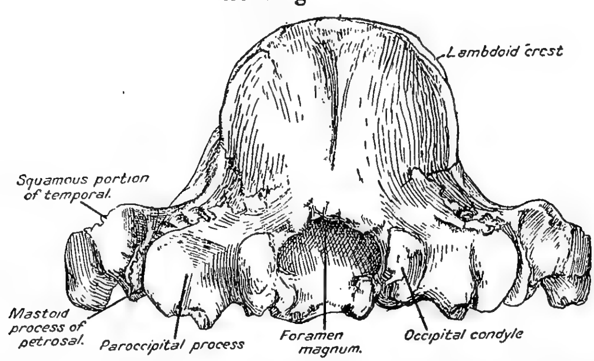
Unfortunately, from the nature of the case, the skulls belonging to the two natural casts above described are unknown, having been destroyed by weathering, but those from which the remaining casts were made are preserved and are here discussed. Four such skulls are known. Of these, two [M. 8150 (a cast) and M. 10228] certainly belong to *Zeuglodon osiris* Dames, from the Qasr-el-Sagha beds (Upper Mokattam = Bartonian), north of Lake Birket-el-Qurun in the Fayum. One (M. 9266) is the skull of *Prozeuglodon atrox* Andrews, from the lower part of the Birket-el-Qurun beds in a valley twelve kilometres W.S.W. of the Gar-el-Gehannem, lying to the west of the lake. This last specimen may be regarded as the paratype of the species and is described and figured in the British Museum Catalogue of the Fossil Vertebrata of the Fayum (1906, p. 243). The fourth skull (M. 10173), forming the middle term of the series, seems from the nature of the matrix to have been obtained from the Birket-el-Qurun beds at the western end of the lake from an horizon intermediate between those from which the other species were found. This, however, in the absence of definite information from the collector is not certain. This skull appears to belong to a hitherto-undescribed species which has been called *Zeuglodon intermedius* by Dr. Dart, the characters of which are given below.

Numerous other Zeuglodont remains have been collected from various horizons in Egypt, and there is some difference of opinion as to their determination and relationship to one another. For the purposes of the present paper these may be disregarded and the series represented by *Prozeuglodon atrox*, *Zeuglodon intermedius*, and *Zeuglodon osiris* alone considered. The characters of the skulls of these species completely support Dr. Dart's conclusion, founded on the endocranial casts, that these three species represent terms in a phyletic series.

The skull of *Prozeuglodon* has been described in detail in the catalogue (*loc. cit.*), so that here it will only be necessary to refer to a few characters easily comparable with those of the other forms. The occipital surface (text-fig. 22) above the foramen magnum is wider than high (if the height* be taken as 100, the width is 110) and it is only gently concave from side to side. The foramen magnum and the occipital condyles are both large. The convexity of the portion of the cranial wall formed by the parietal

Text-figure 22.



Occipital surface of skull of *Prozeuglodon atrox* Andrews. M. 9266. About ¼ nat. size.

and squamosal is greater than in the later forms, while the sagittal crest is much less developed. The posterior border of the narial opening is over the space between the first and second premolars and the snout is less prolonged anteriorly than in the later forms. Some of the above peculiarities may be dependent to some extent on the circumstance that the skull described is not quite adult.

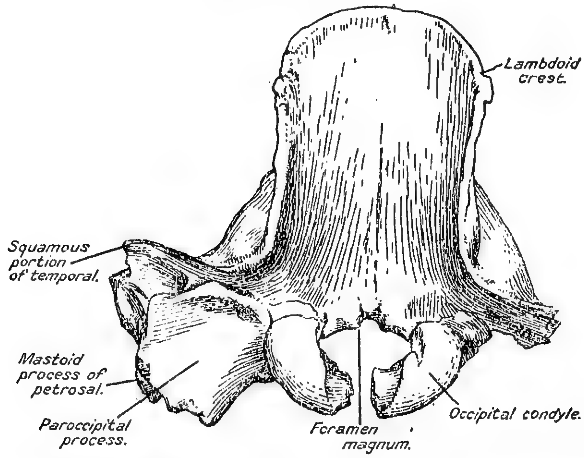
The type-skull M. 10173 of *Zeuglodon intermedius* (text-fig. 23) is not complete, the zygomatic arch and the terminal portion of the snout being missing; the teeth also are much broken. In it the width of the occipital surface (text-fig. 23) is much less in proportion to its height* (height 100, width 66), and it is much more concave from side to side than in *Prozeuglodon*.

* In each case the height is measured from the upper border of the foramen magnum to the point of union of the sagittal and lambdoidal crests.

But the concavity is regular and the middle portion of the lambdoidal crest is not suddenly reflected backwards as in *Zeuglodon osiris*. The occipital condyles and foramen magnum are relatively smaller than in *Prozeuglodon*, the occipital crest more developed, and the convexity of the lateral cranial surface less marked. The snout was more slender and more prolonged in front of the narial opening than in *Prozeuglodon*.

This skull, both in the form of its occipital surface and in other points, closely resembles that described by Stromer as *Zeuglodon osiris* (in his paper of 1908) and distinguished by him as Mn.9. It is very different from that described by the same writer as *Zeuglodon osiris* in 1903 and called in his later paper Mn.1. This latter seems to be the true *Zeuglodon osiris*, its lower jaw

Text-figure 23.



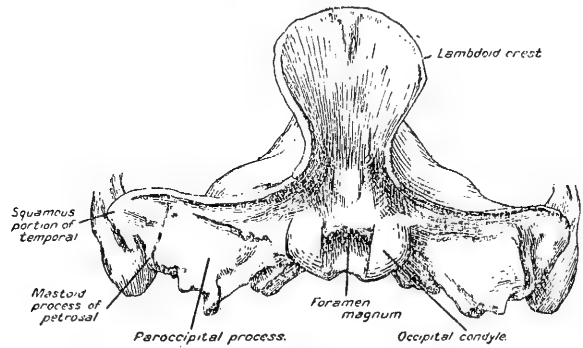
Occipital surface of skull of *Zeuglodon intermedius*, sp. n. M. 10173. About ¼ nat. size.

agreeing very closely with that of the type-specimen of the species as described and figured by Dames (1894). Mn.9 is either the present species (*Zeuglodon intermedius*) or a form between it and *Prozeuglodon*.

The skulls of *Zeuglodon osiris* from which endocranial casts have been made are two in number. One (M. 8150) is very incomplete and reveals only the dorsal contour of the brain. The endocranial cast of this skull was figured and described by Prof. Elliot Smith (1903). The other skull (M. 10228) is a nearly perfect specimen, and in order that the endocranial cast might be made it was skilfully cut into sections and the matrix removed by Mr. L. E. Parsons (text-fig. 24).

The occipital region of this skull agrees exactly with Stromer's specimen Mn.1. It is remarkable for its extreme narrowness compared with its height, the lateral portions of the lambdoidal crests being sharply deflected backwards so that the deeply concave occipital surface has the appearance of being pinched in at the sides. This character is also well shown in the cast of the second skull (M. 8150). If the height be taken as 100 the width is about 44. The occipital condyles and foramen magnum are

Text-figure 24.



Occipital surface of skull of *Zeuglodon osiris* Dames. M. 10228. About $\frac{1}{5}$ nat. size.

still smaller than in *Zeuglodon intermedius* and the convex sagittal crest is much higher. The side walls of the skull show little traces of convexity. The snout seems to have been relatively narrower and perhaps the nostril opened rather further back than in *Zeuglodon intermedius.*

The changes occurring in the stages described are:—

(1) Increasing narrowness and concavity of the occipital surface above the foramen magnum, due mainly to the folding back of the high lambdoidal crests;
(2) increased height of the sagittal crest;
(3) the reduction in the size in the condyles and foramen magnum;
(4) decreasing convexity of the lateral cranial walls accompanying the depression of the upper portion of the brain;
(5) the increase in length and slenderness of the snout and the probable recession, to some extent, of the narial opening.

Changes (1) and (2) result in the increase of the surface for the attachment of the jaw-muscles, and are no doubt correlated with the increasing size and strength of the mandible.

In *Prozeuglodon* the two posterior upper premolars have a large postero-internal buttress supported by a large distinct root. In the two species of *Zeuglodon* this buttress is reduced in size and probably had no distinct root, though from the state of preservation of the specimen this cannot be definitely settled.

Some dimensions in millimetres of the skull in the three forms are given below. These in some instances must be regarded as approximate only:—

	Prozeuglodon. (M. 9266.)	*Z. intermedius.* (M. 10173.)	*Z. osiris.* (M. 10228.)
Length from condyles to tip of snout	673	550	543 app.
Length from lambda to nasal opening	403 app.	453	467
Height of occipital surface from foramen magnum to lambda	120	160	156
Least width of occipital surface between lambdoidal crests	129	106	69
Width across occipital condyles	108	112	92
Width across postorbital processes	264	283	293
Width of foramen magnum	55	52	46
Length of parietal portion of sagittal crest	125	157 app.	170

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EXHIBITIONS AND NOTICES.

May 8th, 1923.

Dr. A. Smith Woodward, F.R.S., Vice-President, in the Chair.

The Secretary exhibited, and made remarks upon, a series of photographs of Big Game from Choma, North Rhodesia.

Miss L. E. Cheesman, F.E.S., F.Z.S., exhibited, and made remarks upon, (1) living specimens of *Peripatus* from Trinidad and (2) a section of a nest of the Stingless Bee from Australia.

Mr. F. Martin Duncan, F.R.M.S., F.Z.S., gave an account of some of the results of his recent work on the microscopic structure of Mammalian hairs, with especial reference to the hairs of the Primates, and illustrated his remarks with a series of photomicrographs taken to demonstrate the character of the cuticular scales.

May 29th, 1923.

Dr. A. Smith Woodward, F.R.S., Vice-President, in the Chair.

The Secretary read the following Report on the Additions to the Society's Menagerie during the month of April, 1923:—

The registered additions to the Society's Menagerie during the month of April were 367 in number. Of these 90 were acquired by presentation, 50 were deposited, 215 were purchased, and 12 were born in the Menagerie.

The following may be specially mentioned:—

2 Adult male Lions (*Felis leo*), from Nairobi, presented by Major-General Sir Edward Northey, K.C.M.G., C.B., F.Z.S., on April 9th.

2 Common Wombats (*Phascolomys mitchelli*), from Australia, and 2 Tasmanian Devils (*Sarcophilus harrisi*), from Tasmania, purchased on April 20th.

2 Superb Glossy Starlings (*Spreo superbus*) and 1 Abyssinian Barbet (*Trachyphonus margaritatus*), from North-East Africa, new to the Collection, presented by Mr. Alfred Ezra, O.B.E., F.Z.S., on April 15th.

A collection of animals from Gambia, presented by H.E. Capt. C. H. Armitage, C.M.G., D.S.O., F.Z.S., consisting of a Wart-Hog, 6 Guinea Baboons, Marabou Storks, &c.

A small collection of birds from Colombia, presented by Mr. W. K. Pomeroy, F.Z.S., containing 2 Prince Albert's Curassows and several Tanagers.

A Tail-lined Tree-Snake, *Dendrelaphis caudolineatus*, and an Iridescent Snake, *Xenopeltis unicolor*, from Singapore, both new to the Collection, presented by the Singapore Natural History Society.

Dr. G. M. Vevers, F.Z.S., exhibited, under microscopes, a series of preparations of the parasitic Protozoon *Balantidium coli*, and described a case of Balantidiosis in a Brazilian Tapir now in the Society's Gardens.

Prof. J. P. Hill, F.R.S., Vice-President, exhibited a series of photographs of the Australian Lung-Fish (*Ceratodus*) and of the rivers which it inhabits, and drew attention to the urgent need for effective protection of this rare Vertebrate.

Dr. N. S. Lucas, F.Z.S., exhibited, and made remarks upon, a mucous cyst from the frontal sinus of a Cercopitheque.

Mr. C. Tate Regan, M.A., F.R.S., exhibited lantern-slides of photographs of the Spotted Basking Shark (*Rhinodon typicus*), and made the following remarks:—

The first of these photographs represents a specimen 38 feet long captured by Captain Charles Thompson off Miami, Florida, in 1912. It was set up by a taxidermist, mounted on a truck, and taken round for exhibition. At the time certain American newspapers published stories about it that were not strictly accurate, and to the effect that it was a monster unknown to science that had been blown up from the depths by a volcano, etc., etc. The second photograph represents a *Rhinodon* about 30 feet long, which was run into by a large steamship off the coast of Brazil and was carried along for several hours, with the anterior $\frac{1}{4}$ of the body on one side of the bows and the rest on the other; when the vessel stopped it floated free and sank (*cf.* Gudger, Natural History, xxiii. p. 62, New York, 1923). Mr. Regan also exhibited some deep-sea fishes taken by the 'Dana' expedition, under the leadership of Dr. Johannes Schmidt. This expedition cleared up the life-history of the Common Eel (*Anguilla vulgaris*), but it also accomplished much other work of great importance. The fishes exhibited belong to the very rare and little-known genera *Gigantura* and *Stylophorus*, which agree in having telescopic eyes placed close together and directed forwards. One *Gigantura* had swallowed a *Chauliodus* considerably larger than itself.

June 12th, 1923.

Sir S. F. Harmer, K.B.E., F.R.S., Vice-President, in the Chair.

The Secretary read the following Report on the Additions to the Society's Menagerie during the month of May, 1923:—

The registered additions to the Society's Menagerie during the month of May were 214 in number. Of these 149 were acquired by presentation, 32 were deposited, 22 were purchased, 2 were received in exchange, and 9 were born in the Menagerie.

The following may be specially mentioned:—

2 Elephants (*Elephas maximus*), from Burma, presented by Dr. Saw Po Min on May 16th.

A collection purchased from the Soudan Government on May 14th, consisting of 1 female Giraffe (*Giraffa camelopardalis*), 1 Wart-Hog (*Phacochœrus africanus*), 4 Arabian Bustards (*Eupodotis arabs*), and 2 Northern Secretary-Birds (*Serpentarius serpentarius gambiensis*).

2 Abyssinian River-Hogs (*Potamochœrus hassama*), new to the Collection, purchased on May 5th.

Mr. D. Seth-Smith, F.Z.S., and Dr. P. H. Manson Bahr, D.S.O., F.Z.S., exhibited photographs and sketches, and made remarks upon, the display of Hunstein's Magnificent Bird-of-Paradise (*Diphyllodes magnifica hunsteini*).

Miss Alyse Cunningham exhibited, and made remarks upon, a Cinematograph record of the Gorilla "John."

Mr. E. G. Boulenger, F.Z.S., exhibited and described models for the rockwork for the Society's new Aquarium, made by Miss Joan B. Procter, F.Z.S.

Mrs. Neale exhibited a living Tree-Hyrax (*Dendrohyrax dorsalis*).

Dr. H. A. Baylis, F.Z.S., exhibited, and made remarks upon, a Nematode Worm, *Toxascaris leonina*, from the Domestic Cat.

Pituitary Gland and Axolotl Metamorphosis.

Mr. E. A. Spaul, F.Z.S., exhibited specimens showing the metamorphosis of axolotls induced by injection of pituitary gland anterior lobe extract, and made the following remarks:—

Recent studies on the relationship between amphibian metamorphosis and endocrine organs have demonstrated the significant rôle of both the thyroid and pituitary glands. The acceleration of the metamorphosis of tadpoles to frogs when fed with thyroid tissue and the failure of thyroidless tadpoles to change until given either thyroid diet or iodine, followed by the conversion of axolotls to salamanders by thyroid diet, showed conclusively the importance of the thyroid and thyroid iodine. Although pituitary diet does not induce metamorphosis in either tadpoles or axolotls, pituitaryless tadpoles fail to transform, whilst axolotls injected with extract from the anterior lobe of the pituitary gland assume adult characters as rapidly as individuals treated with thyroid, which is evidence in favour of the significance of the anterior lobe of the pituitary in metamorphic changes.

The results of experiments briefly outlined here show that the anterior lobe contains an active principle functioning in a definite manner in metamorphosis. Previously only young axolotls had been used, but larger specimens, in some cases beyond that size at which they change in normal environment, were taken, and by tri-weekly injections caused to transform to adults. The rate of metamorphosis depended on the size of the animal and the temperature. The first signs of change appeared much later in the older specimens, but providing the dose was sufficient the process was more rapid. Within two or three weeks of the first injection the change begins and is usually complete by the 40th day in medium size or the 48th day in the oldest types under suitable conditions of temperature. The limits of the latter are 22°–24° C., when the animal remains quite normal throughout the experiment. Low temperature retarded the change, and if too high the animal became sluggish, refusing food, with no noticeable increase in the rate of change.

The approximate limits of the minimal dose were found, but it was not possible to give any relation between the minimal dose within these limits and the weight, as the complexity of the factors, both internal and external, made the production of identical conditions each time, and hence uniformity, impossible. The limits were ·5 grs. of fresh gland per ·5 c.c. injection for small individuals to 1·5 grs. for full-grown animals.

Weights and measurements were taken on days alternating with those upon which injections were made throughout the period of the experiment, but no increase in growth was noted, only a decrease. This does not deny the growth-promoting properties of the anterior lobe, for the animals used were adult and sexually mature, so that reduction previous to metamorphosis was to be expected.

Having ascertained these details, the change resulting from the injection of the anterior lobe extract was applied as a biological test in the examination of the purity and strength of commercially prepared extracts. Quantities up to 1/10 of a clinical dose could be tested in this manner. Of twelve so tested only one successfully brought about the change, although as many as 20 injections were made. The dose was the same in each case, the quantity stated by the manufacturer being taken as a basis and equivalent to the minimal dose as found in previous experiments.

The cause of failure was probably due either to loss of potency during process of manufacture or presence of impurities having an inhibitory effect. As regards the first, the strength of the dose was doubled with no result, so that it was not a question of quantity. The only impurity, apart from those accumulating in process of preparation (a very small amount, if present), and investigation of which was beyond the scope of this work, was the posterior lobe of the gland. The difficulty in separation of the two lobes in dissection and diffusion of active principles during dissection would account for its presence.

It has recently been shown that there is a pigmentation factor located in the posterior lobe, and by its action on the frogs' melanophores a quantitative estimation can be made by determining that concentration which just gives a response. This method was successfully applied here and the quantity of posterior lobe in each extract calculated.

Further, many animals treated refused food, the water in the container became cloudy, smelling of urine, and some eventually died, after becoming greatly distended with fluid, which was found to contain 2·1 per cent. of urea. As the symptoms were the same in each case, and occurred only in specimens injected with extracts and not controls, the cause must have been the same, and introduced by the extract. Therefore the factor was apparently contained in the posterior lobe and responsible for inhibition of activity of anterior lobe secretion. It was possible to compare roughly the amounts present by judging effects on specimens.

On comparing these observations with the results obtained from the pigmentation work, the respective amounts in each extract did not correspond, which seems to show that there were two factors at least which were not identical—the one controlling pigmentation response of the melanophores and the other associated in some way with the flow of urine and inhibiting action of anterior lobe. It is doubtful whether the pigmentation factor itself had any such action.

In conclusion, it can be seen that the anterior lobe extracts as at present manufactured are not pure, containing posterior lobe, which may completely mask metamorphic action of anterior lobe, although a small quantity has no effect. The varying amount in which it may be present shows consistent composition and is not maintained in manufacture. Again, the stated amounts of gland present in commercially prepared extracts is not to be relied upon, as tested by this method.

No. 241.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

May 8th, 1923.

Dr. A. Smith Woodward, F.R.S., Vice-President, in the Chair.

The Secretary exhibited, and made remarks upon, a series of photographs of Big Game from Choma, North Rhodesia.

Miss L. E. Cheesman, F.E.S., F.Z.S., exhibited, and made upon, (1) living specimens of *Peripatus* from Trinidad, and (2) a section of a nest of the Stingless Bee from Australia.

Mr. F. Martin Duncan, F.Z.S., gave a *résumé* of a paper by Mr. H. Burrell, C.M.Z.S., "Note on a Hibernating Female Specimen of the Marsupial *Acrobates pygmæus.*"

Mr. F. Martin Duncan, F.Z.S., gave an account of some of the results of his recent work on the microscopic structure of Mammalian hairs, with especial reference to the hairs of the Primates, and illustrated his remarks with a series of photomicrographs taken to demonstrate the character of the cuticular scales.

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* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

The next Meeting of the Society for Scientific Business will be held on Tuesday, May 29th, at **5.30** P.M., when the following Communications will be made:—

C. TATE REGAN, M.A., F.R.S., F.Z.S.

The Skeleton of *Lepidosteus*, with Remarks on the Origin and Evolution of the Lower Neopterygian Fishes.

Dr. CHAS. F. SONNTAG, F.Z.S.

The Comparative Anatomy of the Tongues of the Mammalia.—IX. Edentata, Dermoptera, and Insectivora.

S. MAULIK, F.Z.S.

New Cryptosome Beetles.

The following Papers have been received:—

R. BROOM, F.R.S., C.M.Z.S.

On the Structure of the Skull in the Carnivorous Dinocephalian Reptiles.

N. A. MACKINTOSH, B.Sc.

The Chondrocranium of the Teleostean Fish *Sebastes marinus*.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

Zoological Society of London,
Regent's Park, London, N.W. 8.
May 15th, 1922.

No. 242.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

May 29th, 1923.

Dr. A. Smith Woodward, F.R.S., Vice-President, in the Chair.

The Secretary read a Report on the Additions to the Society's Menagerie during the month of April 1923.

Dr. G. M. Vevers, F.Z.S., exhibited, under microscopes, a series of preparations of the parasitic Protozoon *Balantidium coli*, and described a case of Balantidiosis in a Brazilian Tapir now in the Society's Gardens.

Prof. J. P. Hill, F.R.S., Vice-President, exhibited a series of photographs of the Australian Lung-fish (*Ceratodus*) and of the rivers it inhabits, and drew attention to the urgent need for effective protection of this rare Vertebrate.

Dr. N. S. Lucas, F.Z.S., exhibited, and made remarks upon, a mucous cyst from the frontal sinus of a Cercopitheque.

Mr. C. Tate Regan, M.A., F.R.S., F.Z.S., exhibited, and made remarks upon, photographs of the Spotted Basking Shark (*Rhinodon typicus*). Mr. Regan also exhibited some deep-sea fishes taken by the 'Dana' Expedition, under the leadership of Dr. Johannes Schmidt. The fishes exhibited belonged to the very rare and little-known genera *Gigantenu* and *Stylophorus*, which agree in having telescopic eyes placed close together and directed forwards.

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Mr. C. Tate Regan gave a *résumé* of his paper on "The Skeleton of *Lepidosteus*, with Remarks on the Origin and Evolution of the lower Neopterygian Fishes."

Communications by Dr. Chas. F. Sonntag, F.Z.S., on "The Comparative Anatomy of the Tongues of the Mammalia.—IX. Edentata, Demoptera, and Insectivora," and by Mr. S. Maulik, F.Z.S., on "New Cryptosome Beetles," were taken as read.

The next Meeting of the Society for Scientific Business will be held on Tuesday, June 12th, 1923, at 5.30 P.M., when the following Communications will be made :—

R. Broom, F.R.S., C.M.Z.S.

On the Structure of the Skull in the Carnivorous Dinocephalian Reptiles.

N. A. Mackintosh, B.Sc.

The Chondrocranium of the Teleostean Fish *Sebastes marinus.*

R. I. Pocock, F.R.S., F.Z.S.

The External Characters of the Pigmy Hippopotamus (*Chœropsis liberiensis*) and of the Suidæ and Camelidæ.

Major E. E. Austen, D.S.O., F.Z.S.

A Revision of the Family Pantophthalmidæ (Diptera), with Descriptions of new Species and a new Genus.

Raymond Dart, M.Sc., M.B., and C. W. Andrews, D.Sc., F.R.S., F.Z.S.

The Brain of the Zeuglodontidæ (Cetacea), with a Note on the Skulls from which the Endocranial Casts were taken.

Oldfield Thomas, F.R.S., F.Z.S., and M. A. C. Hinton, F.Z.S.

On Mammals collected by Capt. Shortridge during the Percy Sladen and Kaffrarian Expedition to Orange River.

The following Papers have been received:—

H. C. Abraham, F.Z.S.

A new Spider of the Genus *Liphistius* from the Malay Peninsula, and some Observations on its Habits.

A. Subba Ran, B.A., M.Sc., F.R.M.S., and P. H. Johnson, B.Sc., F.Z.S.

Observations on the Development of the Sympathetic Nervous System and Suprarenal Bodies in the Sparrow.

Malcolm A. Smith, M.R.C.S., L.R.C.P., F.Z.S.

A Review of the Lizards of the Genus *Tropidophorus* on the Asiatic Mainland.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

Zoological Society of London,
Regent's Park, London, N.W. 8.
June 5th, 1923.

No. 243.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

June 12th, 1923.

Sir S. F. Harmer, K.B.E., F.R.S., Vice-President, in the Chair.

The Secretary read a Report on the Additions to the Society's Menagerie during the month of May 1923.

Mr. D. Seth-Smith, F.Z.S., and Dr. P. H. Manson Bahr, D.S.O., F.Z.S., exhibited photographs and sketches, and made remarks upon, the display of Hunstein's Magnificent Bird-of-Paradise (*Diphyllodes magnifica hunsteini*).

Miss Alyse Cunningham exhibited, and made remarks upon, a Cinematograph record of the Gorilla "John."

Mr. E. G. Boulenger, F.Z.S., exhibited and described models for the rockwork for the Society's new Aquarium, made by Miss Joan B. Procter, F.Z.S.

Mrs. Neale exhibited a living Tree-Hyrax (*Dendrohyrax dorsalis*).

Dr. H. A. Baylis, F.Z.S., exhibited, and made remarks upon, a Nematode Worm, *Toxascaris leonina*, from the Domestic Cat.

Mr. E. A. Spaul, F.Z.S., exhibited, and made remarks upon, Axolotls in which metamorphosis had been induced by pituitary-gland injection.

Mr. N. A. Mackintosh, B.Sc., communicated his paper on "The Chondrocranium of the Teleostean Fish *Sebastes marinus*."

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* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. R. I. Pocock, F.R.S., F.Z.S., gave a *résumé* of his paper on "The External Characters of the Pigmy Hippopotamus (*Chœropsis liberiensis*) and of the Suidæ and Camelidæ."

Major E. E. Austen, D.S.O., F.Z.S., gave a *résumé* of his paper "A Revision of the Family Pantophthalmidæ (Diptera), with Descriptions of new Species and a new Genus."

Prof. G. Elliot Smith, F.R.S., F.Z.S., gave a *résumé* of the paper by Mr. Raymond Dart, M.Sc., M.B., and Dr. C. W. Andrews, F.R.S., F.Z.S., on "The Brain of the Zeuglodontidæ (Cetacea), with a Note on the Skulls from which the Endocranial Casts were taken."

Communications by Dr. R. Broom, F.R.S., C.M.Z.S., "On the Structure of the Skull in the Carnivorous Dinocephalian Reptiles," and by Mr. Oldfield Thomas, F.R.S., F.Z.S., and Mr. M. A. C. Hinton, F.Z.S., "On Mammals collected by Capt. Shortridge during the Percy Sladen and Kaffrarian Expedition to Orange River," were taken as read.

The next Meeting of the Society for Scientific Business will be held on Tuesday, October 23rd, 1923, at 5.30 p.m.

A notice stating the Agenda for the Meeting will be circulated early in October.

The following Papers have been received :—

H. C. Abraham, F.Z.S.

A new Spider of the Genus *Liphistius* from the Malay Peninsula, and some Observations on its Habits.

A. Subba Rau, B.A., M.Sc., F.R.M.S., and P. H. Johnson, B.Sc., F.Z.S.

Observations on the Development of the Sympathetic Nervous System and Suprarenal Bodies in the Sparrow.

MALCOLM A. SMITH, M.R.C.S., L.R.C.P., F.Z.S.

A Review of the Lizards of the Genus *Tropidophorus* on the Asiatic Mainland.

J. G. H. FREW, M.Sc., F.Z.S.

On the Larval Anatomy of the Gout-fly (*Chlorops tæniopus* Meig) and two related Acalyptrate Muscids with Notes on their Winter Host-plants.

ARTHUR LOVERIDGE, F.E.S., C.M.Z.S.

(1) Notes on Mammals collected in Tanganyika Territory, 1920–1923.

(2) A List of the Lizards of British East Africa (Uganda Kenya Colony, Tanganyika Territory, and Zanzibar) with Keys for the Diagnosis of the Species.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W. 8.
June 19*th*, 1923.

PAPERS.

1923, Part III. (pp. 483–659).

NOTICE.

The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1923, p. . . . The Distribution is usually as follows:—

Part	I.	issued in	March.
„	II.	„	June.
„	III.	„	September.
„	IV.	„	December.

'Proceedings,' 1923, Part II. (pp. 181–481), was published on July 6th, 1923.

The Abstracts of the 'Proceedings,' Nos. 241–243, are contained in this Part.

The dates of Publication of 'Proceedings' 1830–1858 will be found in the 'Proceedings' for 1893, page 436.

The dates of Publication of 'Transactions' 1833–1869 will be found in the 'Proceedings' for 1913, page 814.

PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY

OF LONDON.

1923.

PART IV.

CONTAINING PAGES 661 TO 1097; WITH 110 TEXT-FIGURES, 3 PLATES, AND 1 MAP.

DECEMBER 1923.

PRINTED FOR THE SOCIETY,
SOLD AT ITS HOUSE IN REGENT'S PARK.

LONDON:
MESSRS. LONGMANS, GREEN, AND CO.,
PATERNOSTER ROW.

[*Price Twelve Shillings.*]

LIST OF CONTENTS.

1923, Part IV. (pp. 661–1097).

EXHIBITIONS AND NOTICES.

PAPERS.

Contents continued on page 3 of Wrapper.

ZOOLOGICAL SOCIETY OF LONDON.

INSTRUCTIONS TO AUTHORS.

Owing to the cost of printing, the Publication Committee beg to draw the attention of Authors submitting papers for publication by the Society to the following Regulations. If the conditions are not observed, papers may have to be returned :—

1. MSS. submitted for publication must be written in a clear and legible handwriting, or, preferably, be type-written, and must be in final form for printing. The MSS. should be written on one side of each sheet only, and the pages clearly numbered. All tables of contents, references to plates, or legends to illustrations in the text, etc., must be in their proper places, **with page and plate numbers left blank**; and the position for the text-figures must be indicated. References to literature must be exact, with the page number as well as the volume number and date.

2. Proofs and their Correction.—Two copies of the slip proof, and a page proof for final revision, will be sent to the Author, **but it is important that all serious corrections be made on the slip proof.** Expenses for proof corrections are very heavy, but, if the MSS. comply with Regulation 1, should not exceed 25 per cent. of the printers' charges. If the cost of corrections exceeds 25 per cent., a proportion of the excess will be charged to the Author.

3. Revised proofs must, if possible, be returned within one week from the date of their receipt by the Author.

4. The Author receives 30 copies of reprints free, and, with the sanction of the Publication Committee, may obtain leave to buy extra copies, at the cost price charged by the printers and engravers to the Society. The number of separate copies required must be stated when returning the proof.

5. Illustrations.—Drawings intended to be reproduced as line-block text-figures should be drawn with a good black ink, such as "Process Black" or the best "Indian ink" on white "Bristol board." All lines and dots must be clear and sharp, and no washes or colours used. Wash drawings are not suitable for reproduction as text-figures. All necessary lettering **must be clearly, but lightly, indicated in pencil,** so that the engravers

may insert sharp, well-drawn letters. Each drawing should be numbered to tally with the text-figure number given in the MSS., and be accompanied by a short, concise, and legible descriptive legend. When making drawings for text-figures, or grouping drawings, it should be borne in mind that, when reduced, the figures must not exceed the dimensions of the printed matter on the page of "Proceedings," viz.:—$3\frac{1}{2} \times 6\frac{1}{2}$ inches. Drawings or photographs intended for reproduction as plates will have to be reduced, when necessary, to fit a space of $4\frac{4}{10} \times 7$ inches.

6. Copyright.—No use whatever is permitted of the type or illustrations prepared for the Society's Publications other than for the Separate Copies mentioned above, unless the leave of the Committee has been obtained, and recorded on the Minutes. Permission is given only with the consent of the Authors of the papers, if alive, and the source of the text and illustrations shall be stated in the work in which they are used. The use of illustrations from the Society's Publications, if within five years of the date of publication, will be granted only upon the payment of half the cost of their production. All communications made to the Society shall, if accepted for publication, be regarded as the property of the Society, and not returned to the Authors, except for the purpose of comparison with the proof when set up in type.

Note.—The Publication Committee is always ready to give Authors who apply for it, permission to reproduce matter that they have contributed to the Society's "Proceedings" and "Transactions," but the Society has been advised that a formal assignment from Authors is necessary to enable it to protect copyright against third parties.

ZOOLOGICAL SOCIETY OF LONDON.

This Society was founded in 1826 by Sir Stamford Raffles, Mr. J. Sabine, Mr. N. A. Vigors, and other eminent Naturalists, for the advancement of Zoology and Animal Physiology, and for the introduction of new and curious subjects of the Animal Kingdom, and was incorporated by Royal Charter in 1829.

The Society consists of Fellows, Imperial Fellows, Honorary, Foreign, and Corresponding Members, elected according to the By-Laws. It carries out the objects of its foundation by means of its collection of living animals, by its Library, and by its Scientific Publications.

The Office of the Society, Regent's Park, N.W. 8, where all communications should be sent, addressed to "The Secretary," is open from Ten till Five, except on Saturdays, when it closes at ONE P.M.

The Library, under the superintendence of Mr. F. Martin Duncan, F.R.M.S., F.R.P.S., F.Z.S., is open daily (except Sunday) from Ten A.M. till Five P.M.; on Saturdays, Ten A.M. till One P.M.

The Library is closed from Good Friday to Easter Monday, and upon all other Bank Holidays. It is also closed annually for cleaning during the month of September.

The Meetings of the Society for General Business are held in the Meeting Room at the Society's Office on the third Wednesday of the month at 4.30 P.M. except in September and October.

The Meetings for Scientific Business are held in the Meeting Room at the Society's Office fortnightly on Tuesdays, except in July, August, September, and December and January, at half-past Five o'clock P.M.

The Anniversary Meeting is held on the 29th of April, or the nearest convenient day, at Four P.M.

The Society's Gardens are open daily from Nine o'clock until Sunset, or 8 P.M. when sunset is later. Dr. G. M. Vevers is the Superintendent, Mr. D. Seth-Smith, Curator of Mammals and Birds; Mr. Edward G. Boulenger is Director of the Aquarium; Miss Joan B. Procter, F.L.S., is Curator of Reptiles; Miss L. E. Cheesman, F.E.S., is Curator of Insects; Dr. C. F. Sonntag is Anatomist; Dr. N. S. Lucas, Pathologist; Prof. R. T. Leiper, F.R.S., with the assistance of a panel of experts, examines and reports on the Parasites; Prof. G. H. Wooldridge, F.R.C.V.S., is Honorary Consulting Veterinary Surgeon; and Dr. R. W. A. Salmond, O.B.E., Honorary Radiologist to the Society. Applications for anatomical or pathological material, or for facilities for work in the Prosectorium should be addressed to the Secretary.

TERMS FOR THE ADMISSION OF FELLOWS.

FELLOWS pay an Admission Fee of £5, and an Annual Contribution of £3, due on the 1st of January, and payable in advance, or a Composition of £45 in lieu thereof; the whole payment, including the Admission Fee, being £50.

No person can be deemed a FELLOW until the Admission Fee and first Annual Subscription of £3 have been paid, or the annual payments have been compounded for.

FELLOWS elected in November and December are not liable for the Subscription for the year in which they are elected.

PRIVILEGES OF FELLOWS.

Fellows have Personal Admission to the Gardens upon signing their names in the book at the entrance gate, and may introduce Two Companions daily.

The Wife or Husband of a Fellow can exercise these privileges in the absence of the Fellow.

Until further notice, Fellows will receive 40 undated Green Cards, available on any Sunday or week-day up to the end of February of the year following the year of issue, and 20 White Cards available on any week-day up to the same date. Twenty of the Green Cards may be exchanged for a book containing two Orders for each Sunday in the year. Twenty White Cards may be exchanged for a book of dated Week-day Orders, each Order available for any day during the week except Sunday. Special children's tickets are no longer issued, but the Green and White Cards are perforated, and each half is valid for a Child under twelve years of age. It is particularly requested that Fellows *will sign every ticket* before it goes out of their possession. Unsigned tickets are not valid.

Fellows are not allowed to pass in friends on their written order or on presentation of their visiting cards.

Fellows have the privilege of receiving the Society's ordinary Publications issued during the year upon payment of the additional Subscription of One Guinea. This Subscription is due upon the 1st of January, and must be paid before the day of the Anniversary Meeting, after which the privilege lapses. Fellows are likewise entitled to purchase these Publications at 20 per cent. less than the price charged to the public. A further reduction of 20 per cent. is also made upon all purchases of Publications issued prior to 1881, if above the value of Five Pounds.

Fellows also have the privilege of subscribing to the Annual Volume of 'The Zoological Record,' which gives a list of the Works and Publications relating to Zoology in each year, for the sum of Two Pounds Ten Shillings. Separate divisions of volumes 39 onwards can also be supplied. Full particulars of these publications can be had on application to the Secretary.

Fellows may obtain a Transferable Ivory Ticket admitting two persons, available throughout the whole period of Fellowship, on payment of Ten Pounds in one sum. A second similar ticket may be obtained on payment of a further sum of Twenty Pounds.

Any FELLOW who intends to be absent from the United Kingdom during the space of at least one year, may, upon giving to the Secretary notice in *writing*, have his or her name placed upon the "dormant list," and will then be called upon to pay an annual subscription of £1 only during such absence, or in the event of returning to the United Kingdom before June 30th in any year to pay the balance of the ordinary subscription. After three years a Dormant Fellow must make a further application to be retained on that list.

Any FELLOW, having paid all fees due to the Society, is at liberty to withdraw his or her name upon giving notice in *writing* to the Secretary.

Ladies or Gentlemen wishing to become Fellows of the Society are requested to communicate with "The Secretary."

P. CHALMERS MITCHELL,
Secretary.

Regent's Park, London, N.W. 8.
December, 1923.

MEETINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON

FOR

SCIENTIFIC BUSINESS.

1924.

TUESDAY,	FEBRUARY	5 and 19.
,,	MARCH..........	4 and 18.
,,	APRIL	1 and 15.
,,	MAY	6 and 20.
,,	JUNE..............	3.
,,	OCTOBER	21.
,,	NOVEMBER	4 and 18.

The Chair will be taken at half-past Five o'clock precisely.

ZOOLOGICAL SOCIETY OF LONDON.

LIST OF PUBLICATIONS.

The scientific publications of the Zoological Society of London are of two kinds—"Proceedings," published in an octavo form, and "Transactions," in quarto.

According to the present arrangements, the "Proceedings" contain not only notices of all business transacted at the scientific meetings, but also all the papers read at such meetings and recommended to be published in the "Proceedings" by the Committee of Publication. A large number of coloured plates and engravings are issued in the volumes of the "Proceedings," to illustrate the new or otherwise remarkable species of animals described therein. Amongst such illustrations, figures of the new or rare species acquired in a living state for the Society's Gardens are often given.

The "Proceedings" for each year are issued in four parts, paged consecutively, during the months of March, June, September, and December. From January 1901 they have been issued as two half-yearly volumes, indexed separately.

An "Abstract of the Proceedings" is published by the Society on the Tuesday following the date of the Scientific Meeting to which it refers. It is issued along with the "Proceedings," free of extra charge, to all Fellows who subscribe to the Publications, but it may be obtained on the day of publication at the price of Sixpence, or, if desired, sent post free for the sum of Six Shillings per annum, payable in advance.

The "Transactions" contain such of the communications made to the Scientific Meetings of the Society as, on account of the nature of the plates required to illustrate them, are better adapted for publication in the quarto form. They are issued at irregular intervals.

Fellows and Corresponding Members, upon payment of a Subscription of One Guinea *before* the day of the Anniversary Meeting, are entitled to receive the Society's Publications for the year. They are likewise entitled to purchase the Publications of the Society at 20 per cent. less than the price charged to the Public. A further reduction of 20 per cent. is made upon purchases of Publications issued prior to 1881, if they exceed the value of Five Pounds.

Fellows also have the privilege of subscribing to the Zoological Record for a sum of Two Pounds Ten Shillings (which includes cost of delivery), payable on the 1st of July in each year; but this privilege is forfeited unless the subscription be paid *before* the 1st of December following.

The following is a complete list of the publications of the Society already issued.

TRANSACTIONS OF THE ZOOLOGICAL SOCIETY OF LONDON.

4to. 20 vols. and Index.

				Price to Fellows.	Price to the Public.
Vols. I.–IV. (out of print).					
Vol. V., containing	67	Plates ..	(1862–66)	5 4 3	6 19 0
„ VI., „	92	„ ..	(1866–69)	11 5 0	15 0 0
„ VII., „	73	„ ..	(1869–72)	10 4 0	13 12 0
„ VIII., „	82	„ ..	(1872–74) ...	9 8 3	12 11 0
„ IX., „	99	„ ..	(1875–77) ...	12 1 6	16 2 0
„ X., „	95	„ ..	(1877–79) ...	10 0 3	13 7 0
Index, Vols. I.–X.		....	(1833–79)	0 7 6	0 10 0
Vol. XI., containing	97	Plates ..	(1880–85)	9 12 0	12 16 0
„ XII., „	65	„ ..	(1886–90)	5 8 0	7 4 0
„ XIII., „	62	„ ..	(1891–95)	6 8 3	8 11 0
„ XIV., „	47	„ ..	(1896–98)	5 5 0	7 0 0
„ XV., „	52	„ ..	(1898–1901) ..	5 15 6	7 14 0
„ XVI., „	38	„ ..	(1901–1903) ..	5 8 0	7 4 0
„ XVII., „	41	„ ..	(1903–1906) ..	5 18 6	7 18 0
„ XVIII., „	43	„ ..	(1907–1911) ..	4 1 0	5 8 0
„ XIX., „	24	„ ..	(1909–1910) ..	10 4 0	13 12 0
„ XX., „	53	„ ..	(1912–1915) ..	11 10 3	15 7 0
„ XXI.—Part 1. (7 Plates & 12 Text-figs.)			(June 1916)	2 5 0	3 0 0

Since 1916 (Vol. XXI. Part I.) publication of the Society's Transactions has been temporarily suspended, owing to the high cost of production.

In consequence of a re-arrangement of the stock of the 'Transactions,' the Society is now able to offer for sale, at the reduced price of £30, sets of Vols. V.–XVI. inclusive.

PROCEEDINGS OF THE COMMITTEE OF SCIENCE AND CORRESPONDENCE OF THE ZOOLOGICAL SOCIETY OF LONDON. 8vo. 2 vols. (Letterpress only).

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Part I.	1830–31.	1 vol. 8vo., out of print.		
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PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF LONDON.

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Parts I., VII.–IX., XI., XIV., XV., out of print.

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The Parts of this series containing Coloured Plates are out of print.

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PROCEEDINGS OF THE GENERAL MEETINGS FOR SCIENTIFIC BUSINESS OF THE ZOOLOGICAL SOCIETY OF LONDON.

8vo. 46 vols. and Index.

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LISTS OF THE ANIMALS IN THE SOCIETY'S GARDENS.

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CATALOGUE OF THE LIBRARY of the Zoological Society of London (Fifth Edition.) 8vo. 1902. Cloth, 6*s.*

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ZOOLOGICAL RECORD.—Vol. 58, containing literature relating chiefly to the year 1921, was published in October 1923, price £3. Vol. 59, for the year 1922, is being prepared as usual, price £3, or subscription, if paid in advance, £2 10*s.* 0*d.*

P. CHALMERS MITCHELL,
Secretary.

Regent's Park, London, N.W. 8.
December, 1923.

These publications may be obtained at the SOCIETY'S OFFICE *or through any bookseller.*

34. On the Structure of the Skull in the Carnivorous Dinocephalian Reptiles. By R. Broom, M.D., F.R.S., C.M.Z.S.

[Received May 7, 1923: Read June 12, 1923.]

(Text-figures 1–17.)

Index.

Though our knowledge of the structure of the Anomodontia and of the various suborders of the Theriodontia is fairly complete, the more primitive groups—the Dromasauria and the Dinocephalia—are still very imperfectly known. Of the Dinocephalia we know a good deal of both the skull and skeleton of the Tapinocephaloid group, but of the *Titanosuchus*-like forms we know very little of either the skull or skeleton. The present short paper will add something to our knowledge of these latter types.

The chief reason why so little is known of the giant Dinocephalians while the Anomodonts and Theriodonts are so well known, is that the Dinocephalians in South Africa are in older beds, where they cannot be easily picked out from a loose shale, but are usually in masses of extremely hard limestone. If unweathered out it is only with great difficulty that the bone can be distinguished from the matrix; and when weathered usually much is hopelessly gone and probably much still in the very hard stone. Hence it happens that only a very few skulls are in any museums, and, so far as I know, only two mounted skeletons.

The first Dinocephalian remains from South Africa were collected by Dr. W. G. Atherstone in 1872 and described by Owen in 1876. The front end of a snout of a large form was named *Tapinocephalus atherstonei*. Some vertebræ and other remains were referred to this species, but there is some doubt whether the reference is correct. Nothing was known of the affinities of the form until many years later.

In 1879 Owen described under the name *Titanosuchus ferox* some jaw fragments that had been discovered by Mr. T. Bain.

Many years earlier, fragmentary remains of reptiles which we now know are allied to the South African Dinocephalians were described from the Permian rocks of Russia. Seeley in 1888 visited Russia, examined the specimens described, and figured two genera represented by fair skulls—*Deuterosaurus* and *Rhopalodon*. In 1892 he described the first good skull of a South African Dinocephalian—a skull in the Cape Town Museum collection,—which he named *Delphinognathus conocephalus*, and he founded the order Dinocephalia for the reception of this form and *Tapinocephalus*.

For many years nothing further was added to our knowledge of the Dinocephalia. When in London in 1909 I examined some specimens which had been in the Seeley collection. The most important was a very fine skull of a large Tapinocephaloid reptile, which I referred to *Tapinocephalus atherstonei*, and of which I gave figures. Another important specimen was the top of the head of a Titanosuchid, which I referred to *Titanosuchus ferox*. In 1910 I gave a re-description of *Delphinognathus*. Between 1911 and 1915 in various papers I gave figures and descriptions of the skull and the principal bones of the skeleton of the small Dinocephalian, *Moschops capensis*. From imperfect remains I had previously described a considerable number of Dinocephalians—*Eccasaurus priscus*, *Pelosuchus priscus*, and *Taurops macrodon* of the Tapinocephaloid group, and *Archæosuchus cairncrossi*, *Titanosuchus cloetei*, and *Scapanodon duplessisi* of the Titanosuchid group,

In 1914 Watson described fully all the material in the British Museum. The skull which I had referred to *Tapinocephalus atherstonei* he believed to be a new genus and species, and named it *Mormosaurus seeleyi*. A second imperfect skull he called *Pnigalion oweni*. A third very imperfect skull he named *Lamiasaurus newtoni*. This third skull has a snout of the Titanosuchid type, but an occiput rather of the Tapinocephaloid type; and when in 1914 I examined the specimens in the British Museum, I could not feel at all satisfied that the snout belonged to the occiput. I am therefore pleased to see in Watson's paper on the Theriodontia (1921) that he also recognized there may be an error in referring the snout and occiput to the same animal. To avoid confusion it will be well to regard the snout as the type of *Lamiasaurus newtoni*. Watson refigured the top of the skull of the Titanosuchid which I had referred to *Titanosuchus ferox*, adding the premaxilla, which he found belonged to it. In 1921 he gave new restorations of the skull of *Rhopalodon fischeri*, and finding further fragments of the supposed *Titanosuchus* skull, discovered that it belonged to a distinct type which he named *Anteosaurus magnificus*.

In recent years Haughton has described a complete skull of *Tapinocephalus atherstonei* and a new Tapinocephaloid, *Struthiocephalus whaitsi*, and the skull of a small and probably immature Titanosuchid under the name of *Moschosaurus longiceps.*

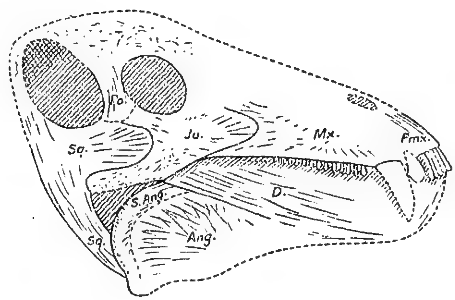
In 1914 van Hoepen briefly described a new Titanosuchid under the name *Jonkeria truculenta.*

Scapanodon duplessisi Broom.

In 1904 I gave under the above name a brief description of a new type of Titanosuchid reptile. The type consisted of jaw fragments with teeth. It was distinguished from *Titanosuchus ferox* Ow. by having relatively much smaller molar teeth, and in those molars having flattened spade-like crowns. The type came from Zeekoegat, in the Prince Albert district. Nothing further has been known of this form till recently.

A few months ago I visited Mr. W. van der Byl at Abraham's Kraal, also in the Prince Albert district, and looked over the large number of specimens that he had collected in recent years on the farm. Among these was the weathered skull of a large Titanosuchid. On critical examination this proves to be

Text-figure 1.



Side view of skull of *Scapanodon duplessisi* Broom. About ½ nat. size.

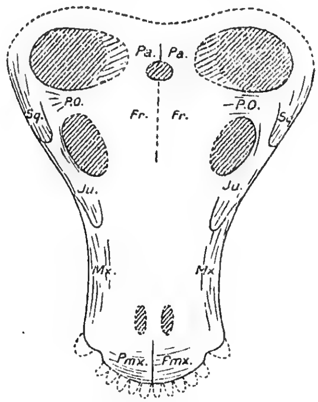
Scapanodon duplessisi, and reveals to us the main features of the skull apart from the palate.

The skull has the nasal, frontal, and parietal regions badly weathered, and the matrix where unweathered is extremely hard. Both sides of the skull are fairly well preserved, and portions of all the teeth of the upper jaw are to be seen.

The general appearance of the skull will be best understood from the figures given. Though the bones of the frontal region are greatly thickened, there is no evidence of great bony bosses overhanging the orbits as in *Anteosaurus*. The pineal foramen is very large, and the occiput is very much flatter and broader than in *Anteosaurus*. The whole skull is also relatively much broader in *Scapanodon*.

There are five large incisors in each premaxilla. The teeth are not well enough preserved to show whether they were pointed or had, like the front teeth of the Tapinocephaloids, a large basal keel. But there seems a little evidence in favour of at least an expanded base. The roots are very long. The fifth incisor is directed more outwards than the others. Between the fifth incisor and the canine is a fair-sized diastema in which the lower canine lies when the jaws are closed. In the very large majority of the Karroo carnivorous reptiles the lower canine passes into a deep cavity in front of the upper canine, but inside the edge of the jaw. In *Scapanodon* there is no doubt that the canine passed up outside the edge of the jaw, as portions of both lower canines are preserved occupying the space between the fifth incisor and the upper canine.

Text-figure 2.



Upper view of skull of *Scapanodon duplessisi* Broom. About $\frac{1}{7}$ nat. size.

The upper canine is a large rounded tooth.

The molars are apparently 14 in number. The anterior are the largest, and they steadily decrease in size in passing backwards.

The nasal bones are completely weathered away, and the frontals badly weathered and largely gone. Enough is left to show the upper margin of the orbit. From the structure of the parts of the frontal remaining it is probable that there was a considerable thickening of the bones in the frontal region.

Though portions of the prefrontals and lachrymals remain, the limits of these bones cannot be made out.

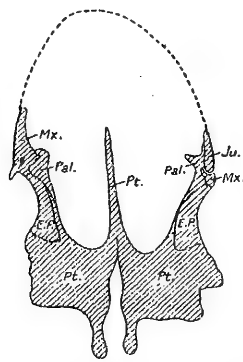
The jugal bones are, however, well preserved, that of the right side being practically perfect. In front it passes well forwards above the posterior end of the maxilla. It forms the whole of the lower border of the orbit. Posteriorly it forms with the squamosal the short, deep, lower temporal arch. The posterior process of the jugal reaches to the descending part of the squamosal. Its lower border is curiously and very coarsely roughened.

The squamosal is a very large bone with an ascending, a descending, and an anterior process. The ascending process forms the back of the temporal fossa, and articulates with the parietal and the tabular. The descending process passes downwards and slightly forwards. It has a moderately developed outer side and a larger occipital face. The occipital face almost completely covers the huge quadrate.

There is a small quadrato-jugal which must be very largely, if not completely hidden from external view by the squamosal.

The quadrate is very badly weathered, but must have been a

Text-figure 3.



Oblique section from the nasal region to the largest part of the pterygoids, in *Scapanodon duplessisi* Broom. About $\frac{1}{4}$ nat. size.

large bone. The upper portion lies far up inside the folded squamosal.

The occiput is not very well preserved, but appears to be essentially similar in structure to the fairly well preserved occiput of the genus to be next described.

The parietals are very thick and the pineal foramen large.

The postfrontals and postorbitals are very badly preserved.

Much of the lower jaw can be seen on one or other side. The general structure appears to be fairly similar to that of the jaw in the Tapinocephaloids. The dentary has a distinct though probably short coronoid process. The angular is large, and forms the greater part of the outer side of the back part of the jaw. The surangular is a powerful bone with a very thick upper edge, which, when the jaw is closed, lies outside the descending process of the squamosal as shown in text-fig. 1.

A slightly oblique transverse section through the skull shows something of the structure of the palate. The section is illustrated in text-fig. 3; it passes from what is the middle nasal region above to near the middle of the deepest part of the pterygoids, and shows the great size of the pterygoids. Inferiorly they are somewhat parted, but above they unite in forming a very high median crest. On each side a section of the ectopterygoid is seen, and above this the posterior spurs of the palatines. On one side a considerable portion of the maxilla is cut across; on the other a part of the jugal and a very small part of the maxilla.

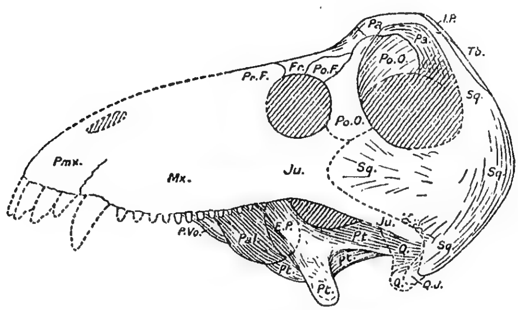
Owing to the extreme hardness of the matrix, no attempt has been made to clear the palate; and as in the following type the palate is fully revealed, it seems unnecessary, for doubtless the structure will be very similar in *Scapanodon* to that seen in the other genus.

Dinophoneus ingens, gen. et sp. nov.

This new genus and species are founded on two skulls discovered by Mr. M. J. van Wyk on the farm Kookfontein, in the Prince Albert district. Though the two skulls are apparently the same species, to avoid any possible confusion specimen B will be regarded as the type.

Specimen A consists of a nearly complete skull which has the

Text-figure 4.

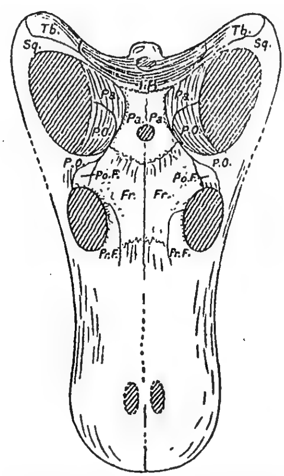


Side view of skull of *Dinophoneus ingens*, gen. et sp. nov. About ⅐ nat. size.

frontal and parietal regions and part of the occiput beautifully weathered out, but with the lower half of the back of the skull completely enclosed in very hard matrix. Most of the snout is preserved, but weathered above badly and with the front teeth mostly gone. The greater part of the left mandible is preserved, but much of it is in hard matrix. The front and back parts of the left mandible are preserved in fairly good condition. Of specimen A there is a fine scapula and, presumably, other skeletal remains—another scapula, a humerus, and many vertebræ—also belong to it.

Specimen B consists of the greater part of a second skull of apparently the same species. This skull was found near the other, and is made up of a large number of considerably weathered scraps. Fortunately it is possible to join all the principal portions, and it is found that nearly the complete skull can be restored. The palate is practically perfect from the occiput to the front of the prevomers. Much of both maxillæ are present, but very little of the premaxillæ. Much of the left jugal arch is preserved, and the whole of the occipital and squamosal regions are nearly complete with the parietals and frontals above. These latter are, however, much weathered.

Text-figure 5.



Upper view of skull of *Dinophoneus ingens*, gen. et sp. nov. About ⅕ nat size. The details of the frontal and parietal regions are from Spec. A.

From the two skulls it is possible to make out all the more important details of the cranial structure.

The premaxillary region is not very well preserved in specimen A, and is lost in specimen B. It is manifest, however, that there have been four large incisors, but none of these is fully preserved. As one has the typical Dinocephalian crown, and the lower incisors preserved also have the Dinocephalian crowns, we may infer as highly probable that the incisors all have this peculiar type of crown. The canine is very large, but not well preserved. Behind the canine are 13 molars, which gradually decrease in size on passing backwards. The thirteen occupy a space of about 143 mm. The crowns are not preserved.

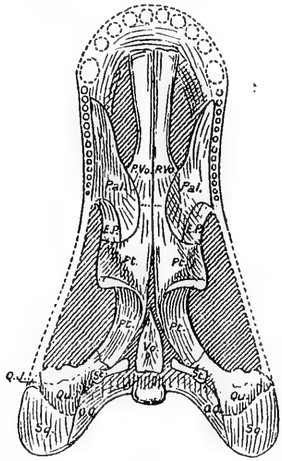
In both specimens the nasal region is lost, but in both the frontal and parietal regions are preserved—in specimen A in perfect condition; in specimen B considerably weathered.

The shape of the frontal and parietal bones will be best understood from the figures. The frontal is moderately flat in front, but bends upwards behind to articulate with the elevated parietal. The interorbital width is 117 mm. There is a fairly large præfrontal which forms much of the supraorbital margin.

The postfrontal is a small bone wedged in between the frontal and the postorbital. The postorbital is large. It forms apparently the whole of the postorbital arch, and passing upwards forms about half of the upper wall of the temporal fossa.

The parietal is narrow, but very massive. The pineal foramen

Text-figure 6.



Palatal view of skull of *Dinophoneus ingens*, gen. et sp. nov. About ⅐ nat size. Entirely drawn from Spec. B.

is large and round. Some distance behind the foramen the fossæ are only 5·3 mm. apart.

The jugal is not well preserved, but specimen B has a large isolated fragment of it. In this fragment is also much of the anterior part of the squamosal.

The squamosal is a very large bone. It forms most of the posterior wall of the temporal fossa. It has a large anterior process which forms much of the subtemporal arch, and a still larger portion of the bone passes downwards and forwards to support the quadrate. The squamosal also forms a large part of the back of the skull, as is shown in text-fig. 7. The quadratojugal is a small bone which lies inside the squamosal for the most part and also supports the quadrate.

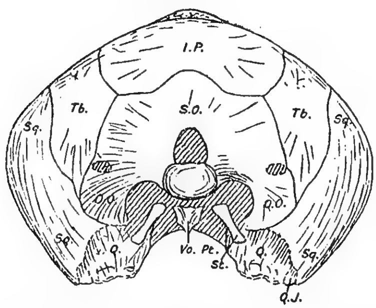
The quadrate is large, and extends far up inside of the squamosal. It has a large internal and anterior process which articulates with the posterior process of the pterygoid.

The occiput is fairly similar to that of the typical Dinocephalians such as *Mormosaurus* figured by Watson. There is a broad interparietal, and the tabular is large and extends down between the squamosal and the supraoccipital. A fairly well developed stapes can be seen in position.

The palate is beautifully preserved in specimen B. The prevomers are very large bones which extend nearly half of the whole length of the palate. The palatines run along the inner sides of the maxillæ and pass backwards to meet the prevomers, the pterygoids, and the ectopterygoids. The ectopterygoids are relatively small, and are situated as shown in text-figs. 6 and 4.

The pterygoids are larger and peculiarly twisted bones. The

Text-figure 7.



Occiput of *Dinophoneus ingens*, gen. et sp. nov. About ⅛ nat. size. Entirely drawn from Spec. B.

anterior part of the palate formed by the prevomers, the palatines, and anterior parts of the pterygoids passes backwards and downwards as far as the huge pterygoid transverse processes. Here the pterygoids bend back on themselves nearly at right angles, and form processes which pass upwards and backwards to articulate firmly with the quadrates, much as in *Sphenodon*.

On the base of the skull between the posterior processes of the pterygoids is a typical Therapsid vomer or "parasphenoid" as it is called by most writers.

Dinartamus vanderbyli, gen. et sp. nov.

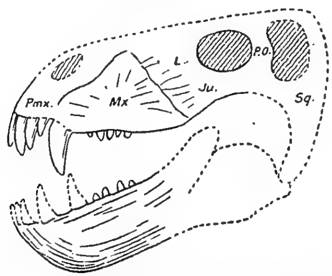
This remarkable new type is founded on some skull fragments discovered at Abraham's Kraal by Mr. W. van der Byl, whose keen interest in palæontology has resulted in the discovery of quite a considerable number of new types. I have much pleasure in associating his name with the find.

The type consists of most of the preorbital portion of a skull with much of the left postorbital region and with an incisor portion which probably belongs to the same skull, but the contact has been lost. Besides these portions, which probably belong to one skull, there is much of the postorbital portion of a second skull, and much of a lower jaw which may belong to either of the skulls—more probably to the first.

There are four large incisors, of which the first is of Dinocephalian type, but the other three incisors may have had pointed crowns. There is some little indication that this may have been so. The canine is large and somewhat curiously bent. There are five well-developed molars which occupy a space of about 54 mm.

In the figure I give (text-fig. 8), some idea of the shape of the skull will be obtained. The surface of the bone is flaked off, so that the sutures given may differ a little from those that would appear on the surface.

Text-figure 8.



Side view of skull of *Dinartamus vanderbyli*, gen. et sp. nov. About $\frac{1}{7}$ nat. size.

The lower jaw which I believe to belong to this species and probably to the same skull is quite remarkable. There are apparently three incisors and what look like two large canines. It is probable, however, that the first is the true canine, and that the other is an enlarged first molar. Following the enlarged first molar are four fairly normal molars. If this view be correct, the dental formula of *Dinartamus* will be $i.\ \frac{4}{3},\ c.\ \frac{1}{1},\ m.\ \frac{5}{5}$.

It will be seen that *Dinartamus* differs considerably from the typical Titanosuchids such as *Scapanodon* and *Dinophoneus*, and ought to be placed in a distinct family which may be called the Dinartamidæ.

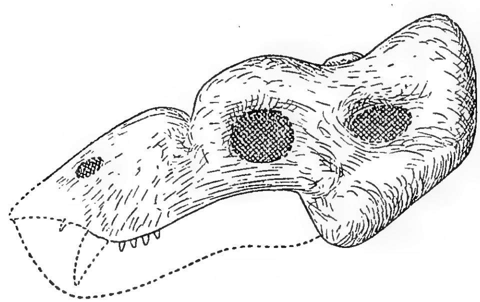
I do not intend in the present paper to enter into the discussion of the affinities of the Titanosuchids with the Tapinocephaloids, or the more interesting question of their affinities with the other Therapsids. But in the meantime one may suggest the advisability of dividing the Dinocephalia into two sub-orders—the Tapinocephalia and the Titanosuchia. The latter suborder would have in it two known families—the Titanosuchidæ and the Dinartamidæ.

BURNETIA MIRABILIS, gen. et sp. nov.

The specimen on which this new genus and species are founded is a nearly perfect skull, without the lower jaw, found by me at Water Krantz, in the extreme north-west of the Graaff Reinet division where it adjoins the Richmond division. At the point where the specimen was found, fossils are very rare, and this specimen was the only one discovered in a couple of hours' hunting on good exposures. The horizon is most probably the lower beds of the *Lystrosaurus* zone.

The skull is quite unlike any other that has ever been found in South Africa or elsewhere; and only now, five years after its

Text-figure 9.



Side view of skull of *Burnetia mirabilis*, gen. et sp. nov.
A little less than ½ nat. size.

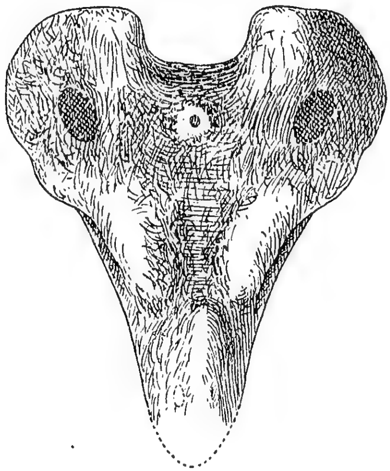
discovery, do I venture to describe it. There seemed a possibility that it might be a late degenerate Titanosuchid, more especially as it has large bony bosses over the orbits somewhat like those seen in the British Museum specimen which Watson has called *Anteosaurus magnificus*. After patiently waiting all these years, I find it convenient to describe it in this paper, which includes an account of all the important details of Titanosuchid structure, because it has some superficial resemblances to Dinocephalians, although not at all a member of that group.

The skull as preserved is 177 mm. long, and was probably, when perfect, about 190, and is 170 mm. wide. Unfortunately, practically all the outer bones of the skull are composed of a very fine-grained, spongy bone, from which it is quite impossible to remove the covering matrix except by grinding, and all trace of sutures seems to be obliterated. As preserved, all the surface bone is covered as by a skin with a thin layer of calcareous matrix. Though this obscures the margins of the orbits and temporal fossæ, all of which are filled with matrix, it does not in any way hide the real structure of the skull.

When seen from above, the most striking peculiarities of the skull are the great posterior width, due to a remarkable development of what are apparently the squamosals, and the presence of five bony bosses—one above the nose, one over each orbit, and one in each post-temporal region.

The snout is relatively narrow. The front part is unfortunately missing, but from what is preserved it must have been sharp, as shown in the figure of the side view, and very possibly it had a horny covering as in *Dicynodon*. There is evidence of one small

Text-figure 10.



Upper view of the skull of *Burnetia mirabilis*, gen. et sp. nov.
A little less than ½ nat. size.

incisor, a little in front of the canine, but I do not think there could have been any in front. The canine is a large, flattened tooth which passes well forward. Behind the canine are four small molars. The canine measures 12 mm. × 5·5 mm. The four molars occupy 18·5 mm., and the first is situated 4 mm. behind the canine.

The orbits are small, and wide apart and entirely lateral. Above each is a large oval boss which completely hides the orbit from upper view. A deep transverse valley is present between the back of the nasal boss and the fronts of the two orbital bosses. There is a fairly wide space between the orbital bosses which is transversely concave and antero-posteriorly slightly convex.

Behind the frontal region is seen the pineal foramen, which is relatively small but stands in a little rounded elevation of bone. The foramen stands in practically the middle of a very wide parietal region. The back part of the orbital boss is continued as a less thickened bony area above the small temporal fossa, and then rises into the huge post-temporal boss which passes both upwards and backwards. Whether this post-temporal boss is formed by the parietal, tabular, or squamosal cannot be made out. This huge boss is continued outwards and downwards into what is manifestly the squamosal region, and forms a huge "cheek" not unlike that of a *Pareiasaurus*. That the cheek is not Pareiasaurian in structure is manifest from the fact that there is an undoubted temporal fossa.

In front of the temporal fossa there is a small boss on what is probably the jugal bone.

The palate is fairly well preserved, but I have not at present been able to satisfactorily clear it. So far as can be seen, it resembles that of the Gorgonopsians more than that of other Therapsids. As in the Gorgonopsian palate, there are a pair of dentigerous areas partly formed by the posterior and main ends of the palatines and partly by the pterygoids. The pterygoids have large transverse processes like those of Therocephalians. There appears to be, as in the Gorgonopsians, no suborbital opening in the palate: if there is one, it must be very small. The posterior part of the pterygoid is very short; the whole distance from the occipital condyle to the transverse pterygoid processes is less than one-third the whole length of the palate. The quadrate is almost completely lost, but it must have been quite small, and not likely larger than that in Cynodonts—possibly smaller.

The occiput has not been cleared. There appears to be a small median part formed by the occipital elements proper with the paroccipitals, and two enormous lateral portions formed evidently mainly by the squamosals.

This remarkable skull I propose to call *Burnetia mirabilis* after James Burnet, Lord Monboddo, the famous Scottish evolutionist of the eighteenth century, the friend of Boswell, of Johnson, and of Burns.

The affinities of *Burnetia* are manifestly nearer to the Gorgonopsians than to any of the other known groups. It is fairly certain that *Burnetia* is a Theriodont. The palatal structure removes it quite clearly from the Dinocephalians and from the Anomodonts. But while *Burnetia* has some affinity with the Gorgonopsians, and may be descended from a Gorgonopsian ancestor, the remarkable specializations it has undergone seem to justify me in placing it in a distinct suborder which may be called Burnetiamorpha. At present it will stand as the sole genus and representative of the sole family—the Burnetidæ.

CLASSIFICATION OF THE THERAPSIDA.

Classification of fossil animals must always be more or less provisional, and will have to be constantly altered as new forms are discovered, and as new light is thrown on previously imperfectly known forms. And yet we must always have a classification of some sort to work by.

Watson, in his recent paper—"The Bases of Classification of the Theriodontia" (P.Z.S. 1921), discusses at considerable length the inter-relationships of the various groups of mammal-like reptiles. The Theriodontia he divides into the following groups:—Gorgonopsidæ, Therocephalidæ, Cynognathidæ, and Bauromorpha. With this grouping I am in entire agreement, but I would prefer to regard the groups not as families, but as suborders. Seeley placed *Diademodon* and *Gomphognathus* in a distinct order—the Gomphodontia. Few would be willing to follow him thus far, but one feels that though they are doubtless allied to *Cynognathus*, the differences are sufficiently great to justify their being put in at least a distinct family. In the Therocephalians also we have quite a lot of genera that can be conveniently grouped together in families within the suborder. If we regard the Therocephalians as a Family merely, we cannot classify the large number of genera unless we resort to Subfamilies. All living Birds resemble each other more closely than do the known Therocephalians. Yet the living birds are subdivided into Superorders, Orders, and Suborders. If the Therocephalians are only entitled to be regarded as a Family, then all living birds ought to be placed in one Family, which would be rather inconvenient. If, however, we regard the Therocephalians as a Suborder, it seems to me no harm will be done, and it will be much more convenient than looking on the group only as a Family.

Watson considers that "the three orders Deinocephalia, Dicynodontia, and Theriodontia may have arisen from a common stock whose direct conservative descendants are the Gorgonopsids, and the Dromosauria may represent a more widely separated stock of the Anomodontia." I expressed a somewhat similar opinion in a paper I sent to the Williston Memorial Volume before Watson's paper appeared. We will probably, however, require many connecting-links before we will be quite sure of the lines of evolution of the Therapsids, and I fear we will never get those links in South Africa. In our oldest Karroo beds that have land reptiles we get already typical Therocephalians, typical Gorgonopsians, typical Dicynodons, and Dinocephalians. If we ever get Ecca beds with good reptiles, we may then get the common ancestors.

We do not, however, need to know the origins of of the groups to get a useful classification, and the one which I would propose is as follows:—

Class **REPTILIA**.

Subclass SYNAPSIDA Osborn.

Super-order *THERAPSIDA* Broom.

Order DINOCEPHALIA Seeley.

Suborder TAPINOCEPHALIA Broom.

,, TITANOSUCHIA Broom.

Order DROMASAURIA Broom.

Order ANOMODONTIA Owen.

Order THERIODONTIA Owen.

Suborder THEROCEPHALIA Broom.

,, GORGONOPSIA Seeley.

,, BURNETIAMORPHA Broom.

,, BAURIAMORPHA Watson.

,, CYNODONTIA Owen.

[Received May 22, 1923.]

ADDENDUM (*27th April*, 1923).—A few days after I had sent off the above paper to London, I was very fortunate in receiving from Mr. van der Byl one or two additional specimens, which enable me to give a full description of the Titanosuchian jaw, and thus to complete all the more important details of the skull structure. On a part of the farm, Abraham's Kraal, that had not previously been prospected, Mr. van der Byl discovered the weathered remains of three Titanosuchians, and collected all that appeared to be portions of jaws. These, when pieced together, proved to be the practically perfect mandible of a large Titanosuchian, the badly weathered and fragmentary jaws of another of the same species, and the dentaries of a huge Titanosuchian, unlike any other that had previously been discovered. It is not often that a collector makes at one time such an important haul; and when we consider that we owe to his discoveries previously made a full knowledge of the skull structure in a group of Mammal-like reptiles hitherto practically unknown, one feels that Mr. van der Byl must be offered the most hearty congratulations of the scientific world.

The large jaw has preserved the roots of four large incisors, the root of a large canine, and the remains of 15 molars. As most Dinocephalians have lost the crowns of the teeth when discovered, and have been named from the general size and arrangement of the teeth, it is very difficult to be sure whether we are dealing with new forms or with species that have previously been named from very imperfect specimens. Owen's *Titanosuchus ferox* is admitted to be a most unsatisfactory type, consisting of little more than the roots of the teeth. In 1903 I made an imperfect dentary in the South African Museum the type of a new species of *Titanosuchus*, under the name *T. cloetei*. It differs in size from Owen's species, but otherwise appears to agree sufficiently closely to make it seem safer to keep it provisionally in the same genus. In 1915 Haughton added a third species, *T. dubius*, which also differs considerably in size from Owen's species, and less markedly from *T. cloetei*. Haughton's specimen came from Abraham's Kraal, and had also been discovered by Mr. van der Byl. The type of *T. cloetei* is registered as coming from "Gamka River." As Abraham's Kraal is on the Gamka River, it is not improbable that Haughton's type and mine came from the same farm, and in any case they are likely to have come from the same horizon. This new jaw discovered by Mr. van der Byl is so near to *T. cloetei* that I think it safest to refer it to this species. *T. dubius* is probably a synonym, the differences being such as might be accounted for by difference of age or sex.

Mandible of Titanosuchus cloetei *Broom*.

The mandible discovered by Mr. van der Byl is nearly perfect, but broken into ten portions. Six small portions are missing, but four of these are quite unimportant. The two others result in the loss of the contact of the articular region of the jaw with the front part, but so little is missing that the jaw can be completely restored with practical certainty. The whole jaw measures in length 565 mm., and, as will be seen from the figures given, the depth is so little in comparison to the length that the jaw appears slender. In reality it is quite a powerful jaw.

The dentition consists of four incisors, one canine, and a series of 15 molars. The incisors, though the crowns are not satisfactorily preserved, are manifestly of the typical Dinocephalian type. The four together occupy a space of about 84 mm. The canine is rounded, and measures at the base of the crown 29 mm. by 28 mm. The 15 molars measure 149 mm. None of the crowns of the molars are well preserved, but from portions preserved it is manifest that they have been flattened with, on the inner side, vertical striæ at the base. The anterior and posterior edges are curved somewhat outwards and have a few coarse serrations. There is clear evidence of dental succession at least as far as the 10th molar.

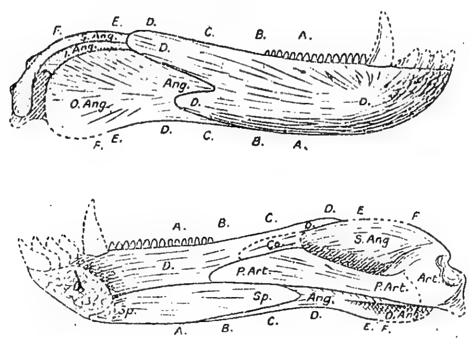
The dentary forms more than half of the outer side of the jaw, but only about a third of the inner side. In front it is fairly massive to support the powerful incisors and canine. There is a large symphysis. There is no coronoid process.

The splenial is an exceptionally long splint of bone which forms nearly the whole of the lower half of the inner face of the front half of the jaw. It forms a small part of the symphysis. Its relations with the other bones will be best understood from the sections given.

The angular is a very remarkably constructed bone. A little in front of the middle region of the jaw the anterior end of the bone is wedged in between the splenial and the dentary, and on passing backwards we find the angular becoming steadily larger. As seen in the figures given, it forms most of the outer side of the back half of the jaw. On the inner side of the jaw it forms a relatively small part, being largely hidden by the prearticular. The very peculiar structure of the bone cannot be readily seen except in section. It consists in the posterior part of the bone being split in two, and containing a large cavity between the two portions.

The coronoid is relatively a very small bone, so small that it might be spoken of as rudimentary. It lies above the anterior part of the prearticular, as can be seen in text-figs. 11 & 12. It is

Text-figure 11.



Right mandible of *Titanosuchus cloetei* Broom. Slightly larger than ½ nat. size.

so fragile that its anterior and posterior limits cannot be clearly made out, the delicate bone being crushed and crumpled. That a small coronoid is present is beyond doubt, and its limits must be very nearly those shown in the figure.

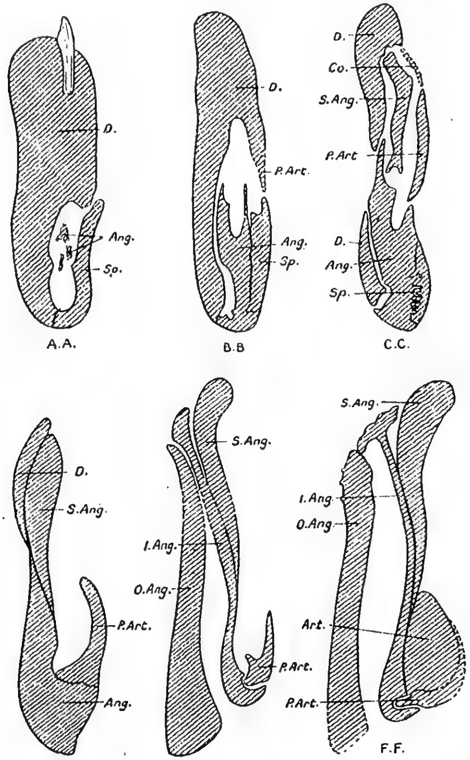
The prearticular is a long, slender bone which runs forward from the articular to about the middle of the jaw. It forms the lower border of the long, narrow opening into the jaw. In front it lies between the coronoid and the splenial. Its mode of attachment to the articular and to the angular will be understood from the sections given.

The surangular is a well-developed bone which forms the upper part of the posterior third of the jaw. Anteriorly it passes forwards between the dentary and the coronoid and prearticular. The specimen does not clearly show how much of the posterior part is surangular and how much articular. Not improbably all the posterior strongly-developed ridge is surangular, and the articular is entirely internal to it. Its relations with the other elements are clearly seen in the sections.

The articular is a strong short bone, which has on its posterior face a broad concave articulation for the quadrate and possibly the quadrato-jugal. Inferiorly there has been a powerful descending articular process. The front part of the articular is on the inner side clasped by the prearticular.

I have figured six transverse sections of the jaw taken at the points marked in the figures. Though the sections are all

Text-figure 12.



Transverse sections of the jaw of *Titanosuchus cloetei* Broom at the points indicated by the corresponding letters on the figures of the jaw.

fractures, they are so nearly transverse that they may be regarded as sections.

Section A, A.—This section is through the 10th molar, which is a replacing tooth just becoming functional. The greater part of the jaw is here formed by the dentary. Below and on the inner side is seen a section of the splenial, and in the cavity of the jaw are a few bony spicules, somewhat crushed and displaced, which represent the anterior end of the angular.

Section B, B.—This section is immediately behind the last molar. Here the jaw is still mainly formed by the dentary, which forms the whole of the outer side and about half of the inner. The splenial is still a fair-sized element, which forms nearly half of the inner side. The angular is, however, in this section considerably larger than the splenial.

Section C, C.—This section, a little distance behind the previous one, is near the posterior part of the dentary. The largest element in this section is the angular, which forms the main portion of the lower half. On its outer side is a section of the lower posterior process of the dentary. On its inner side is a section of the posterior part of the splenial. The upper part of the section is formed by the coronoid portion of the dentary. It is a powerful and curved structure. Underneath it is the anterior process of the surangular. On the inner side of the section is seen a large part of the prearticular cut across, and above this is a section of the feebly-developed coronoid element.

Section D, D.—This section is through the middle of the posterior opening into the jaw. Above is a section of the surangular capped by the coronoid portion of the dentary. Below is the large angular with articulated to it the prearticular.

Section E, E.—Between the previous section and this one the angular splits into two plates, an outer and an inner. As seen in this section, the inner plate is closely attached to the surangular, and the outer plate, which is much the thicker, is quite free from the inner both above and below. The inner plate has attached to its lower end the prearticular, and between the two is the posterior part of the opening into the jaw. The surangular is still a powerful bone.

Section F, F.—This section is only a short distance behind the preceding. The anterior part of the articular is cut across. It is formed of soft spongy bone. Round its lower side lies the prearticular. Above the articular and partly attached to it is the large surangular. Outside the surangular is the inner plate of the angular. Except in its lower part it is quite thin. Above, it broadens out into a delicate bony cap. In the specimen this is somewhat crushed, and is restored in the drawing into what is probably its original condition. Though close to the outer plate it probably is not united to it. The outer plate is very thick. Between the two plates is quite a large cavity.

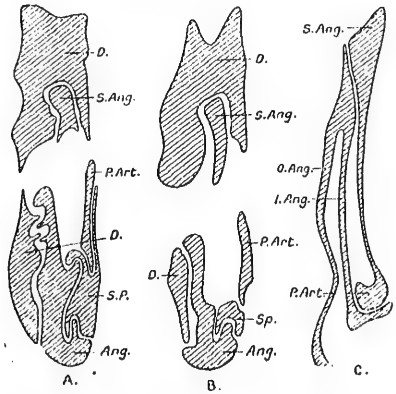
In discussing the affinities of this jaw with the jaws of other early reptiles, we are hampered by the fact that in only a few forms is the jaw structure fully known. In fact, as it is only in the last twenty years that the jaw structure of living forms such as the Lizard and Tortoise has become fully known, we palæontologists may perhaps be forgiven for not having yet been able to reveal the structure of the jaw in all our extinct types. We do, however, know the jaw structure fully in three groups of Therapsids—the Anomodonts, the Gorgonopsians, and the Cynodonts—and fairly well in the homodont Dinocephalians.

We also know fully the structure in some of the Pelycosaurs. In the early reptiles more related to the primitive Diapsidans —the Ichthyosaurs and the Plesiosaurs—the structure is also satisfactorily known.

Quite clearly the affinities of the Titanosuchian jaw are with those of the Anomodonts and Gorgonopsians; and though in each of those three groups the jaws have some quite characteristic features, the jaw structure shows that there is a close genetic relationship between the three.

If the *Titanosuchus* jaw be compared with that of a Gorgonopsian, it will be seen that the two are fundamentally similar.

Text-figure 13.



A. Transverse section of the jaw of *Dicynodon andrewsi* Broom near the middle of the jaw, for comparison with section CC of the jaw of *Titanosuchus cloetei* Broom. The curious overlapping of the prearticular by the splenial is seen.

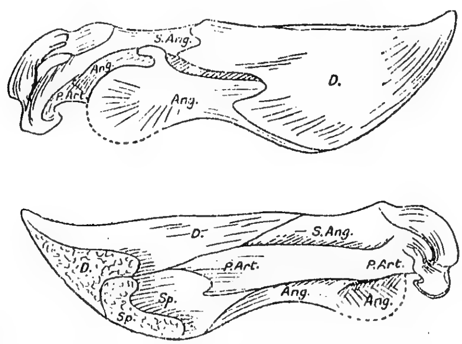
B. A similar section a little further back from another jaw of *Dicynodon* spec.

C. Section through the back of the jaw of a young Gorgonopsian, showing the splitting of the angular. Compare with section EE of jaw of *Titanosuchus cloetei* Broom.

The Gorgonopsian differs in having a much larger coronoid bone, which serves as a splint to bind the back part of the dentary and the front part of the prearticular. The dentary has a well-developed coronoid process which is lacking in *Titanosuchus*. The articular is much smaller in the Gorgonopsian, in keeping with the very small size of the quadrate. The Gorgonopsian angular shows the same sort of splitting that is seen in *Titanosuchus*; but in the Gorgonopsian the outer plate is much less fully developed.

The Anomodont jaw also shows marked affinities with that of *Titanosuchus*, but these are to some extent obscured by the remarkable specializations. There have been one or two points in the Anomodont jaw concerning which opinions have differed which must first be cleared up, and of these the most important is the presence or absence of a coronoid. In 1910 I stated: "There is no coronoid process and no coronoid bone." In 1912 Watson, in his interesting paper on Reptilian lower jaws, describes the coronoid as "a thin slip of bone lying on the inner face of the dentary, separated from it and the splenial by very distinct sutures in several specimens, and apparently just entering the symphysis." And in his figure of the inside of the jaw he shows what he regards as the coronoid. Two years later he expressed some doubts about the coronoid, and stated: "I have never been able to see a clear distinction of the bones in section, and the apparent suture is, perhaps, something else." In 1914 von Hoepen gave by far the best account of the Anomodont jaw that has yet appeared. He paid minute attention to the question of the presence or absence of a coronoid, and gives his conclusion

Text-figure 14.



Right mandible of the Anomodont *Kannemeyeria simocephalus* (Wiethofer).

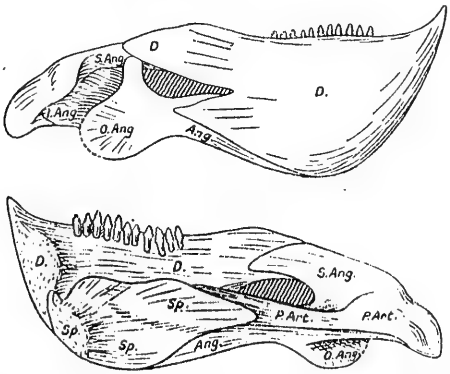
very emphatically: "I can therefore definitely state that the alleged coronoidal element between the dentary and the complementary *does not exist* in *Lystrosaurus* nor in *Dicynodon*." Sollas and Sollas in 1913 also stated that they could "find no trace" of a coronoid. The matter might have been left as settled that there is no coronoid, but unfortunately the deservedly great weight of Watson's authority has resulted in his opinion being accepted by Abel, and his figure of the *Dicynodon* jaw, showing the supposed coronoid, being reproduced in 'Die Stämme der Wirbeltiere.'

In view of the difference of opinion it may not be regarded as superfluous to give two new drawings of the Dicynodont jaw and a couple of views of the jaw of *Endothiodon*.

The jaw of *Kannemeyeria*, like all Dicynodont jaws, shows the peculiar development of the angular. If the inner part of the angular had an upper development against the surangular which met the upper part of the outer plate, the condition would be as in *Titanosuchus*. The Dicynodont angular represents what was probably the pre-Titanosuchian condition. The inner view of the jaw shows the large prearticular and the absence of the coracoid. The whole inside of the jaw is seen to be strikingly similar to that of *Titanosuchus*. The Dicynodon jaw might almost be looked upon as a degenerate Titanosuchian jaw which had lost the rudimentary coronoid, lost the teeth, and developed a new type of articulation.

The *Endothiodon* jaw is a primitive Anomodont type. It differs from that of *Dicynodon* in being a more loosely put together jaw. The prearticular is more slender, and the splenial considerably longer. There is, as in *Dicynodon*, no trace of a coronoid.

Text-figure 15.



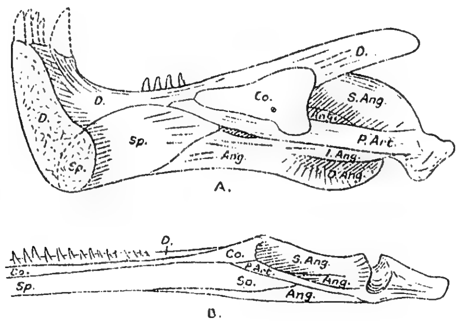
Right mandible of *Endothiodon angusticeps*, sp. nov. This is the jaw of the Endothiodon mounted in the American Museum which I had referred to *E. uniseries* Owen. It differs in the arrangement of the teeth and in the jaw being longer and narrower.

The *Titanosuchus* jaw differs from that of the Pelycosaurs in the fact that these have only a slight indication of the peculiar development of the angular, and also that in these latter there is a long well-developed coronoid. When I first described the jaw of *Dimetrodon*, I thought there were in the Washington specimen two coronoid elements. Williston on re-examining the specimen considered that the supposed dividing suture is a crack. I have had no chance of again examining the specimen, but it is quite likely Williston is right on this point.

Another jaw that may be compared with that of *Titanosuchus* is the Plesiosaurian jaw. I do not consider the Plesiosaurs nearly related to the Therapsids. Some others do. But it must be admitted that there is considerable resemblance in the jaw structure. *Peloneustes* has a very large splenial, a long coronoid, and a small prearticular. The apparent resemblance is, in my opinion, due to the fact that each is but a modification of the early reptilian type.

I give two sections of the jaw of a *Dicynodon* and one of a young Gorgonopsian for comparison with the sections of the jaw of *Titanosuchus*. The first two show how essentially similar *Titanosuchus* is to *Dicynodon*. The third shows how the angular in the Gorgonopsian is split in a somewhat similar manner to that seen in *Titanosuchus*.

Text-figure 16.



A. Right mandible of the Gorgonopsian *Ælurognathus tigriceps* (Broom & Houghton).

B. Posterior two-thirds of right mandible of the Plesiosaur *Peloneustus philarchus* (Seeley), showing the prearticular.

It is perhaps too early yet to definitely state the lines of evolution of the Therapsids, but we are perhaps not far from the truth if we suggest that the Titanosuchians, the Anomodonts, and the Gorgonopsians have all sprung from a common ancestor which was what might be regarded as a pre-Gorgonopsian.

I hope shortly to give a full account of the Gorgonopsian skeleton, and I will discuss at greater length the probable affinities of the groups.

Enobius* strubeni, gen. et sp. nov.

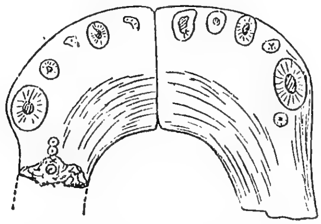
This new genus and species are founded on a specimen consisting of the two dentaries of a large Titanosuchian reptile, quite different from any previously known. The snout of the animal must have been very short and broad and blunt. In each dentary there are the remains of four large incisors, and though the crowns are lost, there is little doubt that they have been of the typical Dinocephalian structure. The four occupy a space of 80 mm. About 7 mm. behind the fourth incisor is a very

* From αἰνο βίας—fearfully strong.

large canine which measures 38 mm. in length by about 30 mm. in width. Behind the canine on the left side are portions of three small molars. There have certainly been four, and very probably there have been five. Those preserved are relatively small. The second measures about the base of the crown 8 mm. × 7 mm. These molars are arranged as shown in text-fig. 17. On the right side the molar arrangement is different. There is preserved only one molar, which is close to the canine, and this is larger than any of the molars of the left side. The section of the tooth measures 11 mm. × 10 mm. Possibly the first molar on the left side belongs to an earlier set. On the right side I can find no trace of other molars.

A considerable part of the posterior portion of the dentary is preserved, which shows that while the jaw is broader than in

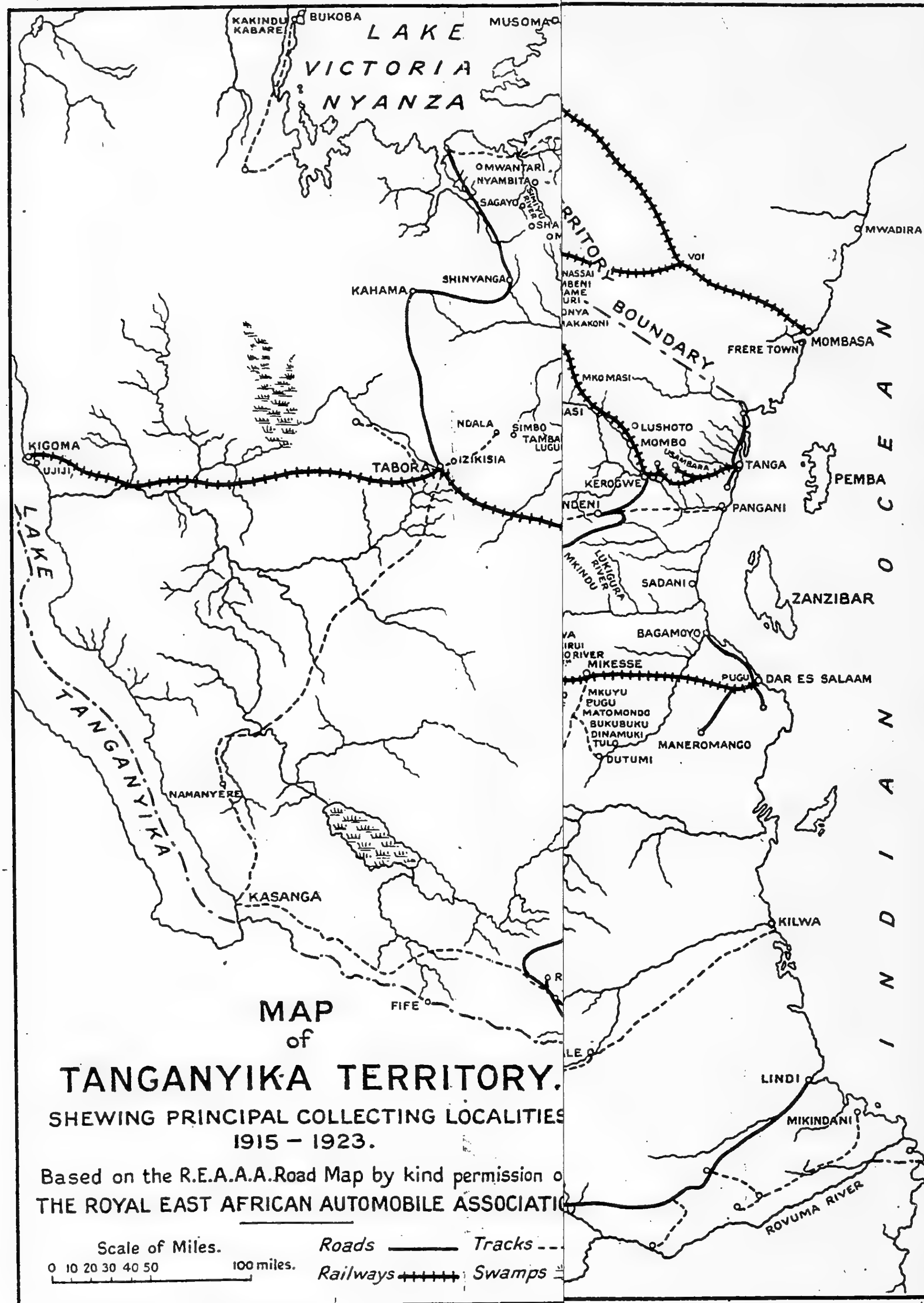
Text-figure 17.



Tooth-bearing portion of the dentaries of *Enobius strubeni*, gen. et sp. nov. A little more than $\frac{1}{4}$ nat. size.

Titanosuchus or *Dinophoneus*, it is also relatively shorter. The measurement across outside the canines is about 215 mm., and with its huge canines and short jaw this new form must have been a much more lion-like carnivore than any of the previously known types.

I have named this giant carnivore after Mr. Frederick P. T. Struben, the proprietor of Abraham's Kraal, who for years has taken a keen interest in palæontology, and as the result of whose interest Abraham's Kraal has become the most important palæontological centre in the Karroo. As Abraham's Kraal adjoins the classical localities Jan Willem's Fontein and Vers Fontein, where the first South African Dinocephalians were obtained, it is likely that ere long, with Mr. Struben's assistance, we will be able to clear up the confusion of the early types and specimens.



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35. Notes on East African Mammals, collected 1920–1923.

By Arthur Loveridge, F.E.S., C.M.Z.S.

[Received August 14, 1923 : Read October 23, 1923.]

Contents.

Introduction.

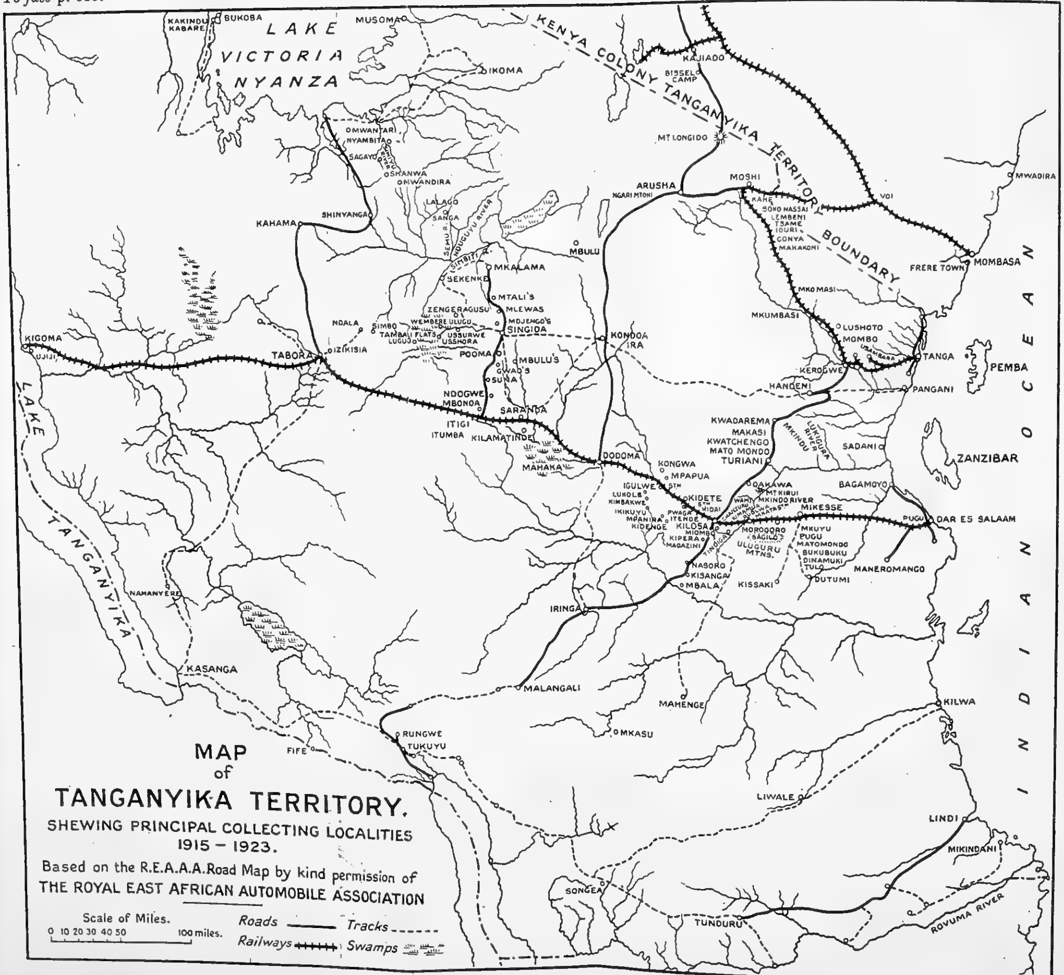
The present paper may be looked upon as supplementary to the 1915–1919 notes *, as localities then recorded are not repeated (except in one or two instances) or similar observations duplicated.

A new feature of the present paper is the inclusion of carefully ascertained native names from only those tribes in whose district the specimens were collected. I consider it of importance that these names should be collected as soon as possible for, with the increasing facilities for travel, many tribes—especially along the Central Railway—are rapidly forgetting their specific names for animals and adopting the blanket-names of the town-bred coast Swahili, who calls every rat, excepting Cricetomys, "Panya." The rat-eating Wagogo and Wanyaturu, on the other hand, have specific names for almost every species.

I have avoided using names supplied by other tribes until that particular animal has been collected in their particular district, as when a native is asked for the name of an animal he is not familiar with he will invariably supply you with the name of the nearest creature in appearance to it that he knows, and at times these may not be even related (*e. g.*, lemurs and squirrels, or mole-rats and blesmols). For these reasons a very large percentage of the names collected by travellers and given by Matschie † are quite wrong (*e. g.*, on p. 65, "Uma mwitu" is given for the jackal instead of "Mbweha"). Umba ya mwitu is the hunting dog, and means "dog of the bush." Matschie gives for its Chigogo (not Kigogo) name "Mbua ya porini," which is merely the concoction of a bright native, as Iminzi is the correct Chigogo equivalent. None but a naturalist can hope to obtain

* Loveridge, "Notes on East African Mammalia." In Jour. E. A. & Uganda Nat. Hist. Soc. No. 16, pp. 38–42; No. 17, pp. 39–69.

† Matschie, "Die Säugethiere D. O. A," 1895.


MAP of TANGANYIKA TERRITORY.
SHEWING PRINCIPAL COLLECTING LOCALITIES 1915 – 1923.
Based on the R.E.A.A.A. Road Map by kind permission of THE ROYAL EAST AFRICAN AUTOMOBILE ASSOCIATION
Scale of Miles.
0 10 20 30 40 50 100 miles.
Roads
Tracks
Railways
Swamps
LAKE VICTORIA NYANZA
KENYA COLONY TANGANYIKA TERRITORY BOUNDARY
INDIAN OCEAN
LAKE TANGANYIKA
ROVUMA RIVER
KAKINDU
KABARE
BUKOBA
MUSOMA
IKOMA
KAJIADO
BISSEL CAMP
MT LONGIDO
ARUSHA
NGARI MTONI
MOSHI
KAHE
VOI
MWADIRA
MOMBASA
FRERE TOWN
OMWANTARI
NYAMBITA
SAGAYO
OSHANWA
OMWANDIRA
LALAGO
SANGA
SHINYANGA
KAHAMA
MBULU
MKALAMA
SEKENKE
MTALI'S
MLEWAS
ZENGERAGUSU
NDALA
SIMBO
WEMBERE
TAMBALI FLATS
LUGUJO
USSURWE
USSHORA
MDJENGO'S
SINGIDA
KONDOA IRA
KIGOMA
UJIJI
TABORA
IZIKISIA
POOMA
MBULU'S
GWAO'S
SURA
NDOGWE
MBONOA
SARANDA
ITIGI
ITUMBA
KILAMATINDE
MAHAKA
DODOMA
KONGWA
MPAPUA
IGULWE
KIDETE
KILOSA
MOROGORO
ULUGURU MTNS.
MKOMASI
MKUMBASI
LUSHOTO
MOMBO
USAMBARA
TANGA
PEMBA
KEROGWE
HANDENI
PANGANI
KWADAREMA
MAKASI
KWATCHENGO
MATO MONDO
TURIANI
SADANI
ZANZIBAR
BAGAMOYO
DAKAWA
MIKESSE
PUGU
DAR ES SALAAM
MKUYU
MATOMONDO
BUKUBUKU
DINAMUKI
TULO
DUTUMI
MANEROMANGO
KISSAKI
NASORO
KISANGA
MBALA
IRINGA
NAMANYERE
KASANGA
MALANGALI
MAHENGE
MKASU
RUNGWE
TUKUYU
FIFE
KILWA
LIWALE
LINDI
MIKINDANI
SONGEA
TUNDURU

native names of animals with any degree of accuracy, and only then by a lengthy cross-questioning can he be certain there is no confusion.

In this connection I should like to express my thanks to the Rev. John Briggs, who very kindly and thoroughly revised my whole vocabulary of Chigogo names, to Messrs. Thomas and Kershaw, for identifying all the primates, bats, and rodents, and a good many in the other groups (most of the ungulates were not submitted owing to the expense of freighting them); to Dr. Baylis, Mr. Stanley Hirst, and the late Hon. N. C. Rothschild, for kindly determining the parasitic worms, ticks, and fleas; and lastly, but not least, to my chief, C. F. M. Swynnerton, Esq., for the encouragement and interest he has shown in my work, and for permission to publish various notes jotted down whilst on official journeys.

The material mentioned in the following pages consists of 920 skins and skulls, comprised as follows:—

Order.	*Families.*	*Genera.*	*Species.*	*No. of Specimens.*
Primates	2	4	10	40
Chiroptera	8	14	22	200
Insectivora	3	5	13	43
Rodentia	9	25	47	417
Carnivora	5	15	28	120
Ungulata	5	20	24	100
Totals	32	83	144	920

As for two years of the time the writer was stationed at Kilosa, in the office of the Game Department, he had to rely on native collectors to a great extent. The success of the collecting is largely due to the enthusiasm of two brothers, Salimu and Nikola, who collected over 600 skins and exhibited the greatest keenness in looking for novelties. It need not be supposed that the skins are poor on this account; on the contrary, I think they will compare very favourably with any made by Europeans.

It is to be regretted that in the great majority of cases the taking of the measurements had to be left to Nikola, but after checking him on many occasions I have sufficient confidence to believe that they are of some value, though it should be borne in mind that a native does not usually see the necessity for such accuracy as does the mammalogist. Where measurements are given in this paper they are always in this order:—(i.) Length from nose to vent. (ii.) Length of tail without terminal hairs. (iii.) Length of hind foot without claws. (iv.) Length of ear from tip to notch. In the case of bats a fifth measurement is added: (v.) Length of wing, sometimes across outstretched wings as well. All figures are in millimetres.

Four new species and one new race have already been described from this material by Mr. P. S. Kershaw *, viz., *Nycteris marica*, *Elephantulus renatus*, *Steatomys muansæ*, *Arvicanthis tenebrosus*, and *Rattus chrysophilus singidæ*.

From East to West and South to North the principal localities mentioned in this paper are:—

TANGANYIKA TERRITORY.

Dar es Salaam District.—Dar es Salaam.
Morogoro District.—Bagilo, Mkindo River, Wami River, Mkata River, Rudewa, Ilonga, Chanzuru, Kimamba, Kondoa, Tindiga, Mbala, Kisanga, Madazini, Miombo, Kipera, Kilosa, Kidai.
Dodoma District.—Kibakwe, Ikikuyu, Mpanira-kwa-Sagoi, Kidenge, Itende, Pwaga, Lukole, Igulwe, Dodoma, Itumba, Mbonoa, Ndogwe, Suna, Gwao's, Mbulu's, Pooma, Singida, Mdjengo's.
Kondoa Irangi.—Mlewa's, Mtali's, Mkalama, Zengeragusu, Usshora, Usurwe, Ulugu.
Tabora District.—Tabora, Izikisia, Ndala, Tambali, Luguo, Wembere Flats.
Mwanza District.—Simbiti River, Nduguyu River, Sanga, Lalago, Mwadira, Shanwa, Sagayo, Nyambita, Mwanza.
Bukoba District.—Bukoba, Kakindu, Kabare.

KENYA COLONY.

Frere Town, Nairobi, Eldoret, Kisumu.

The notes on each animal have been arranged on a definite plan. Firstly, the native names, then distribution, habitats, measurements, variations, breeding seasons, diet, habits, parasites and enemies.

PRIMATES.

CERCOPITHECIDÆ.

CERCOCEBUS ALBIGENA JOHNSTONI Lyd.

A single pair of Johnston's Mangabey were obtained from Kakindu, Bukoba. ♂. 543. 720. 150. 30 mm. ♀. 550. 771. 130. 45 mm.

CERCOPITHECUS DOGGETTI Poc.

A single pair of this monkey were collected at Kabare, where they are very common in the great forests according to my collectors. ♂. 640. 845.50. 40 mm. ♀. 503. 700. 130. 40 mm.

* Kershaw, "On a Collection of Mammals from Tanganyika Territory." Ann. & Mag. Nat. Hist. ser. 9, vol. xi. p. 586, May 1923. Kershaw, Ann. & Mag. Nat. Hist. ser. 9, vol. xii. October 1923.

Cercopithecus albogularis rufilatus Poc.

Senghwa in Kikami and Kisagara, Kima in Kiswahili.

The Blue Monkey was met with at Bagilo, all along the Wami and Mkata Rivers, common at Kilosa, Miombo, and Kipera. It shows a marked preference for primary forest and the great trees burdened with epiphytic growth which fringe the banks of the larger rivers.

A young specimen which I had in captivity for some months, and which was subsequently killed by a leopard, was on several occasions observed to eat "cuckoo spit" of its own accord, and with evident relish! The rapidity with which it pounced upon insects—chiefly grasshoppers—and disposed of them was really remarkable. I have watched adults raiding maize plantations at Tindiga, but they are not so addicted to thieving practices as their relatives *C. p. johnstoni.*

A maggot of *Caudylobia* sp. had to be removed from the fore-arm of the young monkey just mentioned.

Cercopithecus pygerythrus johnstoni Poc.

Ngederi in Kikami and Kisagara, Numbili in Kinyamwezi, Niadengwa in Chigogo, Tumbili in Kinyaturu, Kinyiramba, and Kiswahili.

Seen or collected at Bogoti, Tindiga, Kilosa, Kipera, Kidai, Itende, Kidenge, Mpanira, Ikikuyu, Kibakwe, Lukole, Igulwe, Usshora, and Ulugu.

The largest male measured 543. 650. 130. 35 mm., and female 470. 535. 121. 40 mm. They probably breed all the year round: notes of females with young at their breasts were made in February (Igulwe) and July (Tindiga). A newly-born young one was found in a shamba at Kilosa, it weighed 14 ozs., and measured 180. 270. 65. 25 mm. (26. vii. 22).

A large female monkey in a dying condition was brought to me by a native, who said it had been attacked by a Martial Hawk-Eagle. As the native carried a bow and arrows I was rather doubtful of the story, but on skinning it later no hole was found but the skull was dinted and cracked. It had two old breaks in its tail which were healed. At Kidenge a party of monkeys in the euphorbious thorn-scrub on the side of the mountain raised a great outcry and kept it up for half-an-hour; on enquiring the reason from some natives who were idly watching, I was told that an eagle had dropped down from the sky and was perched on a rock near the monkeys (Kidenge, 14. ii. 23).

The Bogoti specimen had red acarine parasites on its ears.

Cercopithecus pygerythrus centralis Neum.

Numbiri in Kisukuma.

Two from Sagayo and Kikindu. The larger male measured 490. 620. 150. 30 mm.

Papio cynocephalus Linn.

Hoku in Kikami, Nyabu in Kisagara, Nyani in Kiswahili.

Eight examples of the Yellow Baboon were shot in the neighbourhood of Kilosa, where it is all too common.

The largest male measured 858. 637. 237. 55 mm., and female 685. 565. 170. 48 mm.

I believe they breed pretty well all the year round. Females carrying young were met with in July and August, 1921, May and July, 1922. A female was killed on 10. iv. 22 with a ♀ fœtus weighing 10 ozs. and measuring 171. 136. 52. 22 mm. The young are sometimes carried on the back but generally, and especially when very young, they cling to their mother's breasts, thus being back downwards when she is walking.

A baboon's dietary is too large and varied to record; they break down the mulberry bushes when in fruit with great recklessness, and exhibit this same lack of foresight in their ruthless treatment of paupau trees. In one instance, a tree which was growing against the kitchen wall had its stem gnawed through near the ground so that the tree, which was very heavy with fruit, fell. Their love for paupau fruit emboldens them to come within ten feet of the house.

One of my collectors set a snare for a bushfowl, and on visiting the trap one morning found one leg in the noose and a baboon eating the rest in a nearby tree. I have been told that in Bagamoyo District the natives have the greatest difficulty in keeping fowls owing to the baboons carrying them off, but whether it is the present species that is concerned I cannot say.

If one is armed they are extraordinarily wary and difficult to approach, and if suddenly surprised run away uttering piercing screams, and at other times they treat one with more or less contempt. Other animals seem to derive benefit from association with baboon troops: a female bushbuck was seen with a company in a rubber plantation on many occasions during the spring of 1921, and I saw the same or another running up the road in company with a troop about 3 p.m. in the afternoon of 11. v. 22. On 29. vi. 22, some ten wild pigs with a party of baboons passed within two hundred yards of the house.

Their vitality is both astonishing and heartrending. Somebody having fired at a baboon near the house one day was sure that he had mortally wounded it, but I came upon the poor beast all alone at 6 a.m. two days later. It was crouched upon a sheet of galvanised iron by a deserted German house in the bush, and was applying its jaw to the iron with the very evident object of assuaging the pain, for its lower jaw was torn away on one side. I shot it through the chest at close range, and yet it ran for sixty feet before it dropped dead. I firmly believe the native story that a wounded baboon will clap its hand over a wound and successfully staunch the flow of blood, whether with the intention of leaving no blood spoor I cannot say. Several times I have shot baboons in trees, seen them fall, much blood at the foot of the tree, but no trail left.

Two instances of Yellow Baboons carrying off their companions have come to my notice. In one case a local resident, Mr. Kostellesky, shot a large baboon that was picked up by a still bigger beast, which started down the hill with it. Mr. Kostellesky raised an outcry which caused Capt. Turnley and his natives to run out of the house, when they met the baboon with its burden, which it dropped in fear for its own safety. The wounded animal was too hard hit to be able to move.

The second case was witnessed by Mr. D. W. Bisshopp, who shot a female carrying a young one on the Iringa road. He called to his natives to run and capture the little one, but as they approached another female baboon returned—the rest of the troop were in flight—menaced the boys at close quarters, seized the young one and made off with it.

Mr. Kenny Dillon, of Kissaki, wrote me of a recent and quite authentic case which occurred in his district in February, 1923, where baboons attacked and killed the infant child of a native woman while she was at work in the fields.

Their principal and almost only enemy at Kilosa is the leopard, which they will mob when opportunity offers. Some notes on this will be found under the heading of *F. pardus*.

I have only once found a flea (*Ctenocephalus canis*) on a baboon, and this was upon a healthy male in his prime who had also a good many mites on his breasts and in their neighbourhood. Another male had a large number of nematodes (*Physaloptera mordens* Leip.) in its alimentary canal.

PAPIO NEUMANNI Matsch.

Mhuma in Chigogo, Pooma in Kinyaturu, Poma in Kiramba.

Four specimens of this essentially rock-loving baboon were shot at Mtali's, Ulugu, Usshora, and Zengeragusu. They were also seen close to Mkalama. They were always associated with rocky kopjes or outcrops, and at Mtali's a large troop slept on a huge rock at the summit of a kopje.

The largest male measured 830. 500. 200. 55 mm., and female 700. 390. 190. 50 mm. A native brought a young one, which he had had for two-and-a-half months, into camp at Zengeragusu. Though kept on a leash it was very tame, and the air of abandonment with which it lay back in its owner's arms was truly comical.

At Mtali's the local medicine man came to me for the dorsal vertebræ of an old male; these he claimed were a cure for weakness and backache when worn on the lumbar region.

PAPIO TESSELLATUM Elliot.

Kuku in Kisukuma.

Five specimens from Sagayo, where these baboons haunt kopje country similar to that frequented by Neumann's Baboon, but sleep in the great trees fringing the course of the Simiyu River.

The largest male measured 890. 430. 220. 50 mm., and female 710. 440. 200. 50 mm.

Monkey malaria parasites were found in blood smears taken from a specimen in whose stomach were many nematodes (*Streptopharagus armatus* Blanc).

LEMURIDÆ.

GALAGO PANGANIENSIS Matsch.

Mwegi in Kikami, Kimwegi in Kisagara, Komba in Kiswahili.

Three specimens from the Rufigi, Ilonga, and Chanzuru were taken alive. It was also heard along the Wami and Mkata Rivers at many points, at Kimamba, Tindiga, and Kilosa.

The Ilonga specimen was only a day or two old when found (24. iii. 23) by some natives felling trees and clearing bush: it had probably been dropped by the mother in escaping from a tree which was being felled. I kept it for eight days, feeding it on neat sweetened condensed milk, and occasionally a little water. It seemed to thrive on this diet and relieved itself naturally and regularly. I therefore sent it back to Kilosa in charge of a native who was looking after my other animals: it died three days later (♂. 75. 98. 25. 18 mm.).

The Chanzuru specimen would be about two months old when caught (23. iii. 23), and became very tame, showing a great liking for chicken bones. At the end of a month it was found to be heavily infested with lice, which were destroyed by a single application of paraffin and camphorated oil well rubbed in. The fur assumed its normal appearance in two days, but an eczema, which had been present before, gained ground, and would not react to treatment, so that I had to chloroform the little creature on 23. v. 23.

The Rufigi lemur was adult when captured, and though I kept it for three months it was wild and intractable; it had a very hearty appetite, but having already described the dietary of a Morogoro lemur there is no object in repeating it.

GALAGO SENNAARIENSIS Less.

Three specimens were purchased at Usshora, Sanga, and Sagayo; a fourth which was brought to me alive escaped shortly afterwards. Though adult it did not bite much, but drew blood when it did. The very red eyes are rather a striking feature of this little grey lemur.

♂. 135. 230. 65. 38 mm. (Sagayo); ♀. 180. 250. 65. 38 mm. (Usshora). The latter, killed by a dog, had a large fœtus *in utero* very near birth: ♂. 60. 75. 32. 15 mm.

CHIROPTERA.

Few native languages have specific names for the Bats, though many distinguish between the Megachiroptera and Microchiroptera. The general name for bats in Kinyamwezi and Kisukuma is Tunge; in Kikami it is Ndema; in Kisigara, Gombarema, though in South Usagara Kipurabutu is often employed, though it may be specific for *Pipistrellus nanus*. In Chigogo a bat is Ibudibudi, in Kinyaturu Tai, in Kiramba Tule.

Fruit-bats in Kibena are Wembelema, in Kisagara Pulagutwi. Insectivorous bats in Kinyamwezi are Tuvugulima, in Kibena Mbudibudi.

PTEROPIDÆ.

ROUSETTUS LEACHI A. Sm.

A single specimen from Bagilo on 6. v. 22. ♂. 130. 30. 230. 30. 270 mm.

EIDOLON HELVUM Kerr.

A single specimen was found hanging on a tree in a native maize plot at Mahaka on 27. iii. 22. ♂. 195. 0. 35. 20. 364 mm.

EPOMOPHORUS LABIATUS Temm.

Two males of this Epauletted Fruit-bat were shot in a cocoanut palm and mango tree at Kilosa on 8. v. 23. At times Fruit-bats of this genus are very numerous, and at others only one or two can be found after much search. The larger measured 120. 0. 20. 20. 190 mm.

EMBALLONURIDÆ.

TAPHOZOUS MAURITIANUS Geoffr.

A specimen of the Tomb Bat was shot from the trunk of a cocoanut palm at Kilosa, where they are numerous. One was seen on a baobab at Itende. Parasites in the shape of Nycteribids were found in the fur of the Kilosa specimen.

LIPONYCTERIS NUDIVENTRIS Cretz.

Twelve specimens from Mtali's and Shandwa, where they were found in fissures of the rocky kopjes by my collector. The largest male measured 95. 15. 10. 10. 195 mm., and female 100. 11. 14. 10. 202 mm.; both from the latter locality.

PETALIIDÆ.

NYCTERIS CAPENSIS A. Sm.

Twenty-four specimens from Kilosa, Itende, Igulwe, Suna, and Gwao's from culverts, hollow baobab trees, a darkened vacated room in company with *H. caffer*, and flying in a lighted room. Quite a hundred individuals emerged from one baobab.

The largest male measured 58. 44. 10. 25. 125 mm., and female 55. 60. 10. 33. 130 mm.; both from Kilosa.

NYCTERIS HISPIDA Schreb.

A male from Madazini, near Kilosa, and a female from Bagilo. The former flew into a lighted tent. ♂. 45. 38. 8. 15. 110 mm. ♀. 60. 45. 5. 30. 120 mm.

NYCTERIS LUTEOLA Thos.

Nine specimens from Kilosa and Sagayo. The seven Sagayo bats were brought to me by a native, who caught them in a burrow occupied by a porcupine. Largest ♂ 65. 56. 11. 31. 160 mm., and ♀ 65. 64. 10. 33. 154 mm.; both from Kilosa.

NYCTERIS MARICA Kershaw.

A single specimen, the type, from Tindiga near Kilosa.

MEGADERMIDÆ.

LAVIA FRONS REX Miller.

The Yellow-winged Bat was met with in thorn-bush at Msimba, Kilosa, Mlewa's, Mtali's, Wembere Flats, Nduguyu River, and Sagayo, but purposely not collected.

CARDIODERMA COR (Peters).

Two male Big-eared Bats flew into a lighted room (8 p.m.) at Usshora. They measured 80. 40. 17. 38. 170 mm. and 70. 40. 17. 38. 185–400 mm.

HIPPOSIDERIDÆ.

RHINOLOPHUS LOBATUS Peters.

A single specimen flying in a lighted room at Kilosa. ♂. 55. 25. 8. 15. 130 mm.

One of these bats made three attempts to pick off a moth (*Cylegramma latona*) which was bumping along a lighted ceiling. The third time it was successful (Kilosa, 14. v. 23).

HIPPOSIDEROS CAFFER Sund.

Thirty-two specimens of this Horseshoe Bat were taken at Frere Town, Kenya, Kilosa, and Mbala, flying in a lighted room, in an uninhabited room, and a rock cavern respectively. Of these, nine were males and twenty-three females. They exhibit a great deal of variation in colouring, some being nearly as red as *H. ruber*, others grey or brown. Largest ♂ 55. 35. 7. 15. 130 mm., and ♀ 56. 34. 7. 10. 130 mm.

One female had three huge maggot-like adult female dipterons (*Ascodipteron* sp.) embedded beneath the skin of the elbow-joint of both wings. Many had Nycteribids (*Penicillidia pachymela* Speiser) in their fur, which Major Austen informs me has previously been recorded from Somaliland but the host was unknown.

HIPPOSIDEROS RUBER Noack.

Five specimens from Kilosa and Mbala, where they were taken in company with flocks of *H. caffer* in an uninhabited room and rock cavern respectively. Largest ♂ 55. 35. 8. 14. 145. 333 mm., and ♀ 55. 33. 10. 14. 152–342 mm.

HIPPOSIDEROS MARUNGENSIS Noack.

A single male of this huge Horseshoe Bat was shot at Kilosa (8. v. 23) as it was hanging alone from the midrib of a banana leaf at a height of 12 feet from the ground, the palm being near the bridge below the boma. ♂. 106. 36. 21. 31. 300–642 mm. It measured $25\frac{5}{8}$ inches across the outstretched wings. The only parasite was a mite (larva of a Trombidid) on one of the wing-membranes.

VESPERTILIONIDÆ.

PIPISTRELLUS NANUS Peters.

Known as Kimburugutu in Kikami.

Three male Banana Bats were collected. Two of these were flying at Kilosa, and one was found between the stem and the leaf-stalks of a banana palm, so that they are not wholly dependent on bunches of bananas as would appear from Lang and Chapin's field-notes. Largest ♂ 40. 37. 8. 10 mm.

PIPISTRELLUS KUHLII FUSCATUS Thos.

A male from Bagilo on 6. v. 22 measured 60. 40. 5. 7. 110 mm.

GLAUCONYCTERIS ARGENTATA Dobs.

Sixty-four specimens from Kilosa were killed by two shots from a ·410 collecting-gun; my collector had no idea that he had killed so many till he began to gather them up. As many more flew away from neighbouring banana palms, so that they must be very numerous at certain seasons. Males predominate in an extraordinary way, as there were only eighteen females. All were measured, but 49 were almost identical in their dimensions, viz. 50. 45. 8. 10. 140 mm.

The ovaries of all the females were examined for fœtuses, but without result. The stomachs of more than a score were scrutinised, but the contents were too finely masticated for recognition of any insect, nor were any internal parasites visible under a hand-lens. Four mites (*Pteroptus*) were found upon wing-membranes, but apart from these they appeared free from parasites.

Glauconycteris variegata Tomes.

A single male was found hanging to the ceiling boards of the verandah roof one morning at Kilosa, 18. i. 22. ♂. 47. 53. 7. 12. 150–330 mm.

Molossidæ.

Chærephon limbatus Peters.

Fifteen Free-tailed Bats of this species were obtained from the roof of my house at Kilosa, where they were a great nuisance on account of the strong smell caused by the accumulation of their defæcations above the lining boards. They do not leave the roof till it is very nearly dark. Between 4.30 and 5.30 a.m. they return, making a great swishing noise with their wings—like a ruler struck through the air. This is preparatory to going to roost for the day, which is done to the accompaniment of much squeaking and twittering as they take their places and scuffle along the ridge pole. It is by no means uncommon for them to fly against the gauze meshing of the verandah and fall to the ground. Though *H. caffer* is as common about the house it does not do so, but skilfully avoids all obstacles.

The largest male measured 56. 38. 7. 14. 125–282 mm., and female 60. 40. 10. 18. 128 mm.

Chærephon emini de Winton.

My native collector secured ten specimens from beneath a large slab balanced on a boulder at a height of five feet from the ground at Sagayo.

The largest of four males measured 73. 34. 8. 17. 146 mm., and of six females 72. 36. 7. 18. 155 mm.

Mops osborni Allen.

Five specimens of Osborn's Bat were taken in a hut at Kisumu, where, to judge by the smell, they are excessively abundant in many of the buildings. This very distinct species has only been known from Leopoldville, Belgian Congo, where it was collected by the American Museum Expedition; by the present record its range is considerably extended to the east.

All the bats of this family are a nuisance when they take up residence in dwellings, and I have found them very difficult to dislodge. One of the best methods is to fill the space between roofing-iron and ceiling boards with sprays of thorny mimosa, which presumably tear their wings and cause them to seek shelter in someone else's house not so fortified.

The only male measured 84. 47. 13. 16. 180 mm., and largest female 80. 45. 12. 16. 175 mm.

INSECTIVORA.

Erinaceidæ.

Atelerix hindei sotikæ Heller.

Kalunguyeye in Kinyamwezi, Kilungumesu in Kisukuma, Kinenyifuri in Kibena, Sejesi in Chigogo (also in use among the Wasagara in such parts of their district as the hedgehog occurs), Kengye in Kinyaturu, Kilongomegia in Kiramba.

Of the five hedgehogs collected at Gwao's, Pooma, and Usshora, only one was a male. Most of these were kept in captivity for some time as well as others which escaped. They will drink milk immediately after capture and eat meat readily after considerable chewing. One was seen crossing the road in the moonlight and ran with surprising swiftness. The natives of Singida District stated that they were not at all uncommon. A young one no larger than a tennis ball escaped from a deep wash-basin.

♂. 180. 22. 29. 26 mm. Largest ♀. 175. 18. 28. 25 mm. Stomach of the latter was full of minced insect remains and parasitic worms (*Physaloptera clausa* Rud.). At Pooma the body of one was found disembowelled in the neighbourhood of a kopje; it had evidently been killed by one of the carnivora.

Macroscelidæ.

Rhynchocyon petersi petersi Bocage.

Zagari in Kikami, Mbulusanje in Chigogo. All Elephant Shrews are Sangi in Kiswahili irrespective of species.

A single pair from the Usambara Mountains, which is the type-locality of *R. p. usambaræ* Neum., considered a synonym of *R. p. petersi*.

Rhynchocyon swynnertoni Kershaw.

Zozo in Kikami, but Konghole amongst the Wakami of Mikesse.

A single pair of this recently described Elephant Shrew were obtained by my collector from the type-locality Kipera on 25. ix. 22, after a great deal of trouble, as they take refuge in the long grass immediately they are sighted. I also saw one of these spotted Elephant Shrews cross the road near Madazini. The male measured 370. 240. 67. 34, and the female 250. 205. 67. 31 mm.

Petrodromus matschiei Neum.

Two females, an adult and immature, from Mahaka and Izikisia respectively, the adult measuring 220. 170. 50. 38 mm.

Petrodromus nigriseta Neum.

Sangi in Kikami and Kiswahili.

Two were collected at Kipera; it was also occasionally seen at Kilosa, Chanzuru, Kimamba, and Bogoti.

ELEPHANTULUS PULCHER Thos.

Ten specimens from Sanga, Lalago, and Sagayo. Largest male measured 140. 110. 31. 20 mm., and female 140. 121. 31. 23 mm. Many ticks (*Rhipicephalus* sp. nymphs) were taken from the nape of one specimen.

ELEPHANTULUS OCULARIS Kershaw.

Bulu in Chigogo.

Three specimens from the type-locality Dodoma and from Kidenge. Seen at Igulwe. Occasionally taken in rat-traps, which they probably visit for the ants which are attracted by the bait. ♂. 135. 126. 30. 20 mm. ♀. 135. 126. 30. 20 mm.

ELEPHANTULUS RENATUS Kershaw.

Bulu in Kinyaturu.

Six specimens from Suna, Gwao's, and Mtali's, of which Gwao's was selected as type-locality. It was also seen at Pooma. They have their runways in scattered thorn-bush, the soil is sandy or reddish loam. At night they retire into burrows from which the natives dig them in the early morning, as the Elephant Shrews do not appear to stir until the sun has warmed the chilly morning air. Suna specimens were taken in rat-traps.

Largest ♂ 127. 118. 35. 23 mm., and ♀ 140. 130. 32. 21 mm.

SORICIDÆ.

CROCIDURA MARTIENSSENI Neum.

A single female from Bagilo, Uluguru Mts., 13. vi. 22, measured 150. 100. 20. 5 mm.

CROCIDURA FLAVESCENS Geoffr.

Moonyoonhe in Kikami, Kinyunga in Kisagara.

Two specimens from Kilosa were taken in a rat-trap, where they had probably gone for insects eating the bread bait. Three more were found clinging to maize- and grass-stalks in a flooded area during the rains. ♂. 98. 60. 23. 12 mm. ♀. 95. 58. 15. 11 mm.

A skull was found among the pellets of a Barn-Owl (*Strix f. maculata*), one was recovered from the stomach of a One-streaked Hawk (*Kaupifalco monogrammica*), and another from a snake (*Ramphiophis oxyrhynchus*).

CROCIDURA HIRTA Peters.

Kirukangia in Kiswahili, Nzunga in Chigogo, Junga in Kinyaturu and Kiramba.

Six specimens from Dar es Salaam, Gwao's, Pooma, and Izikisia. Three of these were taken in rat-traps with meat bait. The Dar es Salaam shrews were found beneath heaps of grass and garden refuse in open spaces in the middle of the town, where two half-grown specimens were met with on the same date (21. vi. 23). Largest ♂ 90. 60. 13. 9 mm. (Izikisia), and ♀ 85. 50. 10. 5 mm. (Dar es Salaam).

The Swahili name for a shrew is connected with a widespread belief common to almost all tribes, viz., that a shrew can follow a path or road but cannot cross it; if it attempts to do so it will immediately fall dead. This legend has obviously been invented to account for the not infrequent finding of dead shrews in the road, as is also the case in England. The true cause of death is that they have been pounced upon by genets and mungoose, who, on discovering the pungent smell of their prey, abandon them.

CROCIDURA HINDEI Thos.

A female from Nairobi, measuring 80. 41. 13. 10 mm.

CROCIDURA BICOLOR ELGONIUS Osg.

A female from Eldoret, measuring 45. 31. 9. 7 mm.

RODENTIA.

SCIURIDÆ.

ÆTHOSCIURUS BYATTI Kershaw.

Six examples from Bagilo, Uluguru Mts., of this species so recently described from the Usambara Mts. further impresses me with the correspondence between the mammal and bird faunas of these widely separated mountain ranges.

Largest ♂ 240. 160. 60. 30 mm.; largest ♀ 240. 190. 40. 30 mm.

HELIOSCIURUS RUFOBRACHIATUS NYANSÆ Neum.

Five specimens from Chantwara, of which the largest male measured 245. 270. ? ? mm., and female 250. 235. 55. 21 mm. (native measurements).

HELIOSCIURUS UNDULATUS UNDULATUS True.

A male and female only from Bungu, Usambara Mts.

PARAXERUS PALLIATUS SUAHELICUS Neum.

This Red Squirrel is known as Kimhulindi in Kikami, Chimweje in Chigogo, Sindi in Kinyaturu, Kitungu in Kinyiramba.

Nine specimens from Bogoti, Mkata River, Mbweni, Kipera, and Madazini; also seen in dense maiombo scrub at Ndogwe. It is chiefly found in the tangled undergrowth on the banks of dry water-courses, or in the big trees where patches of primary forest still survive. A few were seen in thorn-trees.

The largest male measured 215. 160. 40. 15 mm., and female 210. 240. 48. 22 mm. Another female of practically the same dimensions held a single diminutive fœtus (Mkata, 24. viii. 21).

They spend a good deal of time running about among the dry leaves beneath bushes picking up food, nibbling here and there, and catching insects. The stomach contents showed vegetable matter like finely powdered meal, with traces of chlorophyll probably representing leaves.

One individual had a mite and three lice in its fur, and a parasitic worm (*Streptopharagus* sp.) in its stomach.

The bodies were eaten by my Wahehe and Wabena porters, and I was told the Wakami also relish them.

Paraxerus ochraceus ochraceus Huet.

This Olive Squirrel is called Kifrooma in Kikami, Kaderi in Kisagara, Ndabi in Kinyaturu, Kipumbu in Kiramba.

Four skins from Mkindo and Mkata Rivers and Ulugu. It was also seen by my collector at Mbonoa. At the second locality it was found in association with *P. p. suahelicus*, which on two occasions it was seen pursuing. Another was observed jerking its tail and chattering in unison with a bird.

Two males measured independently were 155. 160. 38. 18 mm., a female 150. 160. 45. 17 mm. The bodies were eaten by the Wahehe and Wabena porters.

Cricetidæ.

Dipodillus luteus Dollm.

Mbadya in Chigogo, Lebwa in Kinyaturu, Munsa in Kinyiramba, Bewa in Kisukuma.

Twenty-seven specimens from Igulwe, Gwao's, Mbulu's, Pooma, Mdjengo's, Simbo, Nyambita, and Sagayo. It appears to be restricted to dry thorn-bush country, with perhaps a preference for sandy soil. These specimens were obtained by offering a reward to the local natives, who dig them out of their holes with spears, and having killed them, insert the head beneath a piece of string tied below the knee, and return to camp with the pendent bodies and tails of the gerbils swinging to and fro.

Largest ♂ 80. 90. 15. 10 mm., and ♀ 80. 92. 18. 9 mm. The tails and ears of many seemed to be scurfy and diseased.

Taterona vicina vicina Peters.

Panya in Kinyaturu. This was stated to be specific, but this is doubtful as it is the blanket name in Kiswahili for all rats.

Twelve Gerbils from Tindiga, Kimamba, Chanzuru, Uliya, Mbala, Kisanga, Mbonoa, Pooma, and Mlewa's. They were dug out of their burrows in grass-country.

Largest ♂ 172. 174. 33. 20 mm., and ♀ 160. 135. 34. 20 mm.; both from Mlewa's.

One of this, or the next species, was found in the stomach of a hawk (*K. monogrammica*).

TATERONA SWAYTHLINGI Kershaw.

Thirty specimens from Dakawa, Ilonga, Chanzuru, Kilosa, Pwaga, and Ikikuyu. A large series from Kilosa were trapped in ordinary rat-traps baited with bread. Some of the others were dug from their burrows, which were unlined; as many as five individuals were found in a single burrow. These holes are scattered throughout the maiombo bush, usually in small groups or colonies.

Largest ♂ 175. 180. 35. 25 mm., and ♀ 158. 165. 38. 22 mm.

Occasionally they may be seen in daylight; two young individuals (♂. 70. 80. 26. 14 mm.) were observed by the side of the road at Kilosa on 16. vii. 21, and one being killed was found to be swarming with parasites.

One was recovered from the stomach of a Genet (*G. suahelica*).

TATERONA MUANSÆ Matsch.

Nangala in Kinyiramba.

Four specimens from Dombolo and Sagayo. Largest ♂ 150. 170. 35. 22 mm., and ♀ 148. 180. 34. 21 mm.; both from the first locality.

TATERONA TABORÆ Kershaw.

A single female from Izikisia near Tabora. 160. ? 35. 20 mm.

RHIZOMYIDÆ.

TACHYORYCTES IBEANUS Thos.

A pair from Nairobi ♀. 180. 68. 30. 8 mm.

TACHYORYCTES DÆMON Thos.

A pair from Engare Mtoni near Mt. Meru.

MURIDÆ.

DENDROMUS OCHROPUS Osg.

A pair from Nairobi. ♂. 70. 87. 16. 10 mm. ♀. 70. 87. 16 10 mm.

DENDROMUS PUMILIO Wagn.

A female was found at Kipera building its nest attached to grass stems, nest six feet from ground. ♀. 62. 85. 10. 5 mm.

Steatomys loveridgei Thos.

Tulu in Kinyaturu, Ndolee in Kinyiramba.

Seven specimens of this Fat Mouse were taken at Pooma and Mdjengo's. This species was hitherto only known from the type collected by the writer at Lumbo in Portuguese East Africa; its range is considerably extended by these new records. ♂. 85. 40. 12. 15 mm. ♀. 82. 35. 14. 17 mm.

Steatomys muansæ Kershaw.

Ngoso in Kisukuma.

Three specimens of this new mouse from Nyambita and Sagayo have been dealt with by Mr. Kershaw. ♂. 76. 26. 13. 12 mm. ♀. 55. 35. 13. 12 mm. They were found running about on and beside the footpath between 7 and 10 p.m., and killed with canes.

Grammomys surdaster surdaster (Thos. & Wrought.).

Five rats from Bagilo, Bogoti, and Tindiga. Largest ♂ 115. 150. 30. 30 mm. ♀. 110. 70. 35. 18 mm.

Rattus rattus alexandrinus Geoffr.

Mbewa in Kikami, Ngule in Kisagara and Chigogo, Koho in Kinyaturu, Mkinki in Kinyiramba, Ngoso in Kisukuma.

Twenty specimens of the Black Rat were collected at Nairobi, Dar es Salaam, Ilonga, Kilosa, Dodoma, Suna, Gwao's, Pooma, Mdjengo's, and seen at Sagayo.

The largest male measured 175. 165. 35. 21 mm., and female 145. 162. 30. 20 mm.

It seems to be living alongside the local *R. c. microdon* in perfect harmony, both species being not infrequently taken in traps set in the same native hut. I found both species clinging to the back of a meat-safe this evening (Kilosa, 21. xii. 22).

On moving a large cupboard in the office a rat's hoard (it could hardly be called a nest) was found. In it were three unopened and almost ungnawed letters, which had been in an outward dispatching tray on May 31st last. One of these communications was of importance and its loss at that time gave rise to considerable correspondence (Kilosa, 31. xii. 22).

Another rat dragged a pair of cycling-stockings from a chair down a hole; they were there a month and fortunately had never been missed, or the blame would surely have fallen on some hapless native (Kilosa, 24. xii. 22).

On one occasion a live rat was brought to me with hind feet enormously swollen, and three cavities in them seemed to indicate the evacuated holes of larval *Caudylobia* sp. (Kilosa, 27. vii. 22).

I saw a young rat in the middle of the morning running rather blindly along by a wall, and on killing it found it to be swarming with fleas (*Xenopsylla brasiliensis* and *cheopsis*), of which I captured twenty-four. The former flea was taken on another specimen at Kilosa, and *X. cheopsis* from a rat's nest in a pantry at Nairobi. Most of the twenty-four were about the rat's head and fore parts, quite half-a-dozen around its eyes—perhaps this accounted for the strange way it ran into and along the wall (Kilosa, 31. xii. 21).

Black Rats were found in the stomach of a Serval (*F. c. hindei*) and of a Wild Cat (*F. o. ugandæ*), but their chief enemy at Kilosa would appear to be the Barn-Owl, in whose nest many skulls were found. Puff-Adders also account for a few.

RATTUS (ÆTHOMYS) WALAMBÆ PEDESTER Thos.

A single male from Kakindo on 15. i. 23.

RATTUS (ÆTHOMYS) CHRYSOPHILUS SINGIDÆ Kershaw.

The two types from Gwao's, and one from Mdjengo's.

RATTUS (PRAOMYS) DELECTORUM Thos.

A female from Bagilo, on 17. vi. 22, measured 100. 120. 30. 30 mm.

RATTUS (MASTOMYS) COUCHA MICRODON Peters.

Mbuku in Kikami, Ngobari in Kisagara, Mhanyalusangha in Chigogo, Bebea in Kinyaturu, Lituri in Kinyamwezi, and Kungu in Kinyiramba.

Eighty-five specimens from Bagilo; Wami, Mkindo, and Mkata Rivers; Rudewa, Ilonga, Kimamba, Kilosa, Kipera, Rumruli, Mpanira, Ndogwe, Gwao's, Mbulu's, Pooma, Tabora, Izikisia, Sanga, Sagayo, and Koma.

It is a garden rat, particularly numerous in the cultivated plots of the natives; when food is scarce it takes to the grain stores in the roofs of the native huts where, owing to their numbers, they must do a great deal of damage.

The largest male of this fine series measured 135. 114. 22. 19 mm., and female 130. 112. 22. 19 mm.; both from Ilonga. Specimens from the thorn-bush steppe seem to average smaller and are paler, but can be matched by individuals picked out from the Kilosa District series. The grey pelage of the younger individuals tends to become a deep nut-brown as they grow older.

Three females trapped at Kilosa on 25. i. 21 had 7, 8, and 11 embryos respectively. A female from Ilonga on 30. iii. 23 had six fœtuses. At Kimamba on 7. iv. 23 a litter of nine were found in a burrow with their mother. Of these nine, one had a white blaze on its forehead.

A flea (*Xenopsylla brasiliensis*), larvæ of *Caudylobia* sp., and nematode worms were taken from these rats.

These Rodents form the staple diet of many wild creatures, and were recovered from the stomachs of a Civet (*C. c. orientalis*), Genets (*G. suahelica* and *G. d. neumanni*), Mungoose (*H. flaviventris*), Pearly Owl (*G. perlatum*), Red-necked Falcon (*F. ruficollis*), and Banded Harrier Eagle (*C. fasciolatus*). One was disgorged by a House Snake (*B. lineatus*) when captured, and many species of snakes in captivity fed upon them.

Rattus (Mastomys) coucha hildebrandtii Peters.

Two specimens from Bissel Camp near Longido in 1916.

Mus musculus Linn.

A single female of the European Mouse with two new-born young arrived at Kilosa on 8. i. 21 in a box of groceries dispatched from Dar es Salaam two days before. ♀. 68. 76. 15. 11 mm.

Leggada bella bella Thos.

Kidaugi in Kikami, Chimhanga in Chigogo.

Six Pigmy Mice from Dar es Salaam, Kilosa, Dombolo, Sagayo, and Nyambita. One was caught in a tent at Itende, but subsequently escaped. They are not infrequently found in houses.

Largest ♂ 55. 45. 12. 9 mm., ♀ 56. 42. 13. 9 mm.

A nest of very simple construction was found beneath a heap of rotting grass. The nest measured 40 mm. in diameter, and was perhaps 30 mm. deep in the cup. The dead grass of which it was constructed was not woven but loosely yet neatly interlaced to form a cosy cup, a few stalks formed a skeleton roof, but it could not be considered properly domed. It held three blind young ones of a dark fawn colour unlike their parent; one opened its eyes on the 20th inst. (Dar es Salaam, 18. v. 23).

What appeared to be one of these mice was found in the stomach of a Whistling Hawk (*A. sphenurus*?) at Wami River on 9. ix. 21.

Cricetomys gambianus osgoodi Heller.

Nchesi in Kikami.

Seven specimens from Bagilo. There is also one in the Game Dept. collections killed by Capt. Turnley at Kilosa on 14. ix. 22. It must be very scarce at Kilosa, as my collectors never met with it there.

The only male measured 410. 390. 80. 50 mm., largest female 380. 390. 72. 47 mm. They were trapped in native gardens, where they are said to go to eat the maize.

Lophuromys aquilus aquilus True.

Twenty-five Harsh-furred Mice from Eldoret, Mkindo River, and Bagilo. Of twenty-three specimens from the last locality the largest male measured 140. 90. 25. 15 mm., and female 150. 90. 20. 10 mm. Dipterous larvæ found in these rats have been identified as *Caudylobia rodhaini* Gedoelst by Major Austen.

Acomys selousi de Wint.

Meru in Kikami.

A pair from Mkindo River on 5. ix. 21. ♂. 97. 65. 16. 16 mm. ♀. 85. 74. 18. 14 mm. Another was trapped near Mkata River, but too damaged to be preserved. Like so many animals with spinous fur or quills, the skin is very delicate and readily tears.

Pelomys fallax fallax Peters.

Five specimens from Bagilo, Tindiga, and Rumruli. The largest male measured 180. 160. 32. 20 mm., and female 140. 150. 30. 20 mm.

Arvicanthis abyssinicus rubescens Wrought.

Four males from Kakindo and Kabare. ♂. 130. 82. 25. 10 mm.

Arvicanthis abyssinicus muansæ Matsch.

Thirteen specimens from Sanga, Lalago, Shanwa, and Sagayo in Mwanza. They are very numerous, using their well-marked runs in daylight. Largest ♂ 140. 110. 26. 10 mm., ♀ 129. 105. 25. 16 mm.

Arvicanthis abyssinicus nairobæ Allen.

Ten specimens of this well-known form were collected in the garden at Nairobi, where they might be seen foraging near the servants' quarters whenever it was quiet.

Arvicanthis abyssinicus virescens Heller.

Five specimens from Eldoret, of which the largest male measured 160. 122. 31. 23 mm., and female 140. 113. 30. 18 mm.

Arvicanthis abyssinicus neumanni Matsch.

Fudi in Chigogo, Puku in Kinyaturu, Kongo in Kiramba.

Fifty-five from Kidenge, Mpanira-kwa-Sagoi, Ikikuyu, Dodoma, Mbona, Suna, Gwao's, Mbulu's, Pooma, Singida, Mtali's.

A distinct trace of a dorsal stripe in Suna specimens was noticeable when they were alive.

Fleas (*Xenopsylla brasiliensis*) were found in the fur of Dodoma and Mbulu rats.

These rats were recovered from the stomach of an Augur Buzzard (*B. augur*) at Dodoma, and also from that of a Kite (*M. a. parasitus*) at Mtali's. Two were found in the stomach of one large House Snake (*B. lineatus*) at Gwao's.

ARVICANTHIS TENEBROSUS Kershaw.

Twenty-nine specimens from Mtali's, Izikisia, and Tabora.

Mr. Kershaw described this rat as a race of *A. abyssinicus*, but this cannot be the case, as *A. a. neumanni* is found at Mtali's. They are quite distinct. *A. a. neumanni* haunts roads, paths, and open thorn-bush, whilst *A. tenebrosus* was taken entirely from gardens where the natives were cultivating mahoga or sweet potatoes.

Largest ♂ 160. 135. 34. 20 mm., ♀ 160. 135. 34. 20 mm.; both from Mtali's, where only three were collected. Tabora rats were all smaller, the biggest being only 145. 110. 29. 18 mm.

Three White-faced Scops Owls (*O. l. granti*) had each one of these rats in its stomach (Mtali's, 19. x. 21). Also in that of an Augur Buzzard (*B. augur*) on the same day.

LEMNISCOMYS GRISELDA ROSALIA Thos.

A single male from Mkindo River on 5. ix. 21 measured 130. 138. 27. 14 mm. A new-born young one, with eyes still unopened, was found in the roadway at Kilosa on 29. iii. 21. Yng. 55. 32. 12. 3 mm.

LEMNISCOMYS MACCULUS MACCULUS Thos. & Wrought.

A single male from Kabare on 1. ii. 23 measured 120. 130. 26. 15 mm.

LEMNISCOMYS ALBOLINEATUS Osg.

Nyagalla in Chigogo, Kuse in Kinyaturu, Kohe in Kiramba.

Seven specimens from Ndogwe, Suna, Gwao's, Pooma, Mtali's, Kadala, and Izikisia. It was also seen at Mbulu's and Mlewa's. They run about on paths and in the roadway in the early morning, and seek refuge in the manyara hedges. They are not very numerous.

Largest ♂ 110. 118. 25. 14 mm.; ♀ 110. 115. 24. 14 mm.

RHABDOMYS PUMILIO DIMINUTUS Thos.

Two males from Eldoret and Rumruli. ♂. 100. 82. 20. 13 mm.

OTOMYS ANGONIENSIS ELASSODON Osg.

A pair of Swamp Rats were collected at Rumruli on 17. vii. 22.

OTOMYS NYIKÆ CANESCENS Osg.

Two adults and one immature specimen from Nairobi, the young one doubtfully referable to this species. ♂. 151. 91. 27. 18 mm.

PEDETIDÆ.

PEDETES SURDASTER subsp.

The Springhaas is called Kupa in Kiswahili, and Kamandegeri in Kinyamwezi.

A pair were purchased at Tabora on 18. xi. 21. ♂. 305. 320. 130. 71 mm. ♀. 420. 420. 130. 71 mm. The immature male is in perfect pelage; the female has bare patches on her back, possibly resulting from scratching sores. Burrows were common at Mbonoa and Suna; at the latter place one Springhaas was trapped, but a jackal carried it off. I followed the spoor, and saw the jackal.

HYSTRICIDÆ.

HYSTRIX GALEATA Thos.

The Porcupine is known as Nungu in Kiswahili, Kibena, Kikami, Kisagara, Chigogo, Kinyaturn, and Kinyiramba; Huna in Kisukuma.

Five specimens only collected, three others seen, and quills found, at Rumruli, Kipera, Kilosa, Pooma, Shanwa, Sagayo.

The largest male measured 1160. 70. 75. 40 mm., and female 827. 65. 75. 39 mm. Native measurements; both animals from Sagayo.

At Sagayo was a porcupine expert who, I heard, had dug out four of these animals the week prior to my arrival. I therefore engaged him for a week, to study his methods. He first sends his small boys (two at least were his own sons, and wore only the clothes they were born in) to find tracks and follow them to the earth where the porcupine is lying-up. They then fetch their father, who then sticks a horn in each entrance of the burrow. These horns (Topi, Thomson's Gazelle, and Roan, also a large wart-hog tusk) are filled with a pitch-like substance, into which beads have been stuck before it hardened. The result of this is medicine said to prevent any animal that is in the burrow bolting from the entrances, and at the same time robs them of their ferocity so that they will not attack anyone entering the burrow; this is very necessary, as at times jackals or a hyæna are found in the earths.

Having done this, one or more of the small naked youngsters are sent down the hole and follow the course of the burrow underground, sometimes to a distance of thirty or forty feet. I myself have seen a length of thirty feet. On locating the animal at the terminus of the burrow they knock on the roof, and the rest of the party, who are listening for this, reply, and mark the spot. A shaft is then sunk, and so nicely judged in the three instances where I was present, that it breaks into the gallery within a foot of the porcupine who is at the terminus of the burrow. While the shaft is being sunk, sometimes the boy remains in the gallery, singing and shouting to prevent the animal breaking back; so it would appear that not too much faith is placed upon the virtues of the horns.

The youngsters enjoy their work hugely, and have dark rings chalked round their eyes "to enable them to see in the dark." They are simply smothered in red soil, for, indeed, when not otherwise occupied, they play hide-and-seek in the galleries, and pop up unexpectedly from the various entrances, or turn somersaults in the dust.

When the porcupine is uncovered he is speared to death, and being very tenacious of life, does not succumb to wounds that would kill any other animal. In the case of those unearthed for me, I shot them. One of these was shot through the head with a ·22, and I supposed was about dead. I therefore told the "fundi" to bring it out of the burrow, and so demonstrate the truth of his statement that he could handle porcupines with impunity. He was very reluctant, but, pressed by the onlookers, took hold of the animal, which promptly drove four quills into his palm. One of the youngsters sucked the wound, whilst another fetched some green leaves, which he chewed into a paste and spat upon the wounds, with the object of preventing their hurting. Nevertheless, the "fundi" stated next day that he had been unable to sleep from the pain in his hand. I came to the conclusion that, as a medicine-man, he was a downright fraud.

When given a *coup de grâce*, a porcupine's rattle is very active, and every quill in its body vibrates and rattles.

The fundi told me that last month he found two females occupying the same burrow, each having two young, the normal number. The nipples are situated on the side just behind the fore-limbs.

They all swarmed with a very large species of flea (*Pariodontis riggenbachi*), which transferred themselves to my skinners, to the latter's great discomfort.

BATHYERGIDÆ.

HELIOPHOBIUS EMINI Noack.

This Blesmol is known to the Wakami and Wasagara as Fuko.

It would appear to be far from common, as only a single pair (♂. 160. 12. 32. 0 mm., ♀. 180. 14. 30. 0 mm.) were obtained during the three years. Both were taken at Kipera on 5. v. 23.

The presence of these burrowing rodents is made manifest by the heaps of fresh soil, as large as a mole-hill, which they will excavate in the course of a single night. The female was obtained in a mealie shamba by digging some six feet along, the blesmol being found at the terminus, which was only some eighteen inches below the surface. My collector said that it was but a poor method of catching them, as one might dig for hours without overtaking one, and if the excavated soil was fresh the way to capture them was to uncover the hole and blow down the entrance, when the blesmol would return to block it up. You must then prevent its return by pushing a stick behind it before it can get back. He stated that he caught the male in this way.

The stomachs contained finely-gnawed greenish and whitish matter impossible of identification. The natives say they eat ground-nuts (= monkey nuts).

I was told that only females are found, and that possibly males do not come near the surface. This idea has probably arisen from the fact that the testicles are internal, and the penis concealed in a vulva-like opening from which it can be extruded.

The claws of one specimen were sheathed in caked soil, and the silky fur of both had many blobs of the same attached very firmly to the hairs, which do not appear to be so well adapted to the burrowing habits of the blesmol as are those of an English mole.

The only parasites present were some very small mites running over the white skin.

THRYONOMYIDÆ.

THRYONOMYS SWINDERIANUS VARIEGATUS Peters.

The Kiswahili name of Ndesi for the Cane-Rat is in general use throughout the country, and is the only one known to the Wakami, Wasagara, and Wagogo.

Two specimens from Myombo; it was also seen at Mkindo River and Madazini, all localities in the Kilosa sub-district.

Of three specimens examined the only adult was a male (394. 143. 70. 39 mm.), which was shot when entering a down-pointing gun-trap baited with a live goat! The largest female measured 340. 112. 60. 29 mm., and was speared by a native as it ran across the road.

Both my specimens had fleas (*Ctenocephalus felis*) present, and the head of the female was burdened with numerous grey ticks (*Rhipicephalus simus* Koch). One specimen was infested with two species of lice (*Scipio aulacodis* Neum. and *Tricodestes mungos* Stebbe).

LEPORIDÆ.

LEPUS VICTORIÆ Thos.

Hares are known as Sungura in Kiswahili, Buga in Kikami, Kisungula in Kisagara, Sungula in Chigogo, and Siyi in Kisukuma.

Five specimens collected at Mbulu's, Mdjengo's, Usshora, and Sagayo. Hares are easier to see than procure, however, and (spp. non det.) were met with at Kimamba, Kipera, Mpanira-kwa-Sagoi, Ndogwe, Mtali's, Lalago, and Mwadira.

The Sagayo male (450. 95. 100. 130 mm.) in the Game Dept. collection was taken in a gin set in a burrow, which rather suggests that hares may make use of burrows at times when the grass is scanty or has been burnt off. Another hare was caught in a gin set for a leopard; the latter came along later and ate the hare—the spoor was very distinct.

The female (480. 73. 100. 101 mm.) from Mdjengo's held two fœtuses (24. x. 21). A very small leveret (155. 30. 46. 35 mm.) was brought me at Usshora on 6. xi. 21, having been caught by a dog; a larger one was brought me at Mbulu's on 11. x. 21.

Two individuals from Mdjengo's and Usshora were teeming with fleas (*Ctenocephalus felis* and *Echidnophaga larina*), and the former had numerous grey ticks (*Rhipicephalus simus* Koch) as well.

LEPUS CAPENSIS CRAWSHAYI de Winton.

A single individual was collected at Eldoret on 9. xi. 21.

CARNIVORA.

CANIDÆ.

THOS ADUSTUS NOTATUS Heller.

A fine skin but in poor condition was purchased from a native in Mwanza town, the animal having been killed a few miles outside.

A live Side-striped Jackal from Liwale was given the writer by Mr. C. B. Goss in January 1923, when it had already been in captivity a couple of months. It was kept on a leash, with a small native mongrel for a playfellow, they romped together a great deal. It would allow itself to be carried for miles, and liked being petted, but was a fearful coward and hated being shut up at night, when it would howl mournfully as long as it thought there was some likelihood of being released; it preferred sleeping with the native porters under a tarpaulin.

If quietly approached it would allow anyone to stroke it, but if its coat was combed it snapped in the air several times as a warning, and would doubtless bite if the combing was not stopped. It has never bitten the writer, but came very near doing so on several occasions, and bit a steward on board as well as several natives, all of whom were probably to blame for tactlessness. Its teeth are very sharp, and fortunately it only snaps and does not hold on.

When given food it always menaced the person who brought it, and is probably dangerous at such a time. It ate most scraps from the table, meat, raw or cooked, but not tinned or preserved; it appeared to prefer fowls and fish to beef and mutton. For five months it was fed on maize-porridge and soup bones. It regularly overate the maize, disgorged the surplus and, after half-an-hour's rest, would eat it again. It was fond of rice, milk puddings, cakes, biscuits, bread without crusts, and sweet fruits. Its only drink was water, even soups being rejected.

Its attitude toward other animals, including dogs, was decidedly friendly; it endeavoured to make friends with the cat on board, but she was suspicious. At Dar es Salaam dogs often gathered round it in the hotel yard but appeared to fear it, as they would not approach, but growled and moved away.

The animal was kept on a leather rein for five months till he found he could gnaw it through, which he did ten times. I gave up the contest and allowed him to wander about the ship for a week till, finding his way into the crew's quarters, he dragged some clothes from a bunk along the deck, and seizing on a leather belt carried it off and gnawed it in half. He was then fastened with very light wire-rope, but after forty-eight hours cut through that also.

THOS MESOMELAS MCMILLANI Heller.

Mbweha in Kiswahili. It has no name in Kikami, but is called Kewe in Kisagara, and Nhyewe in Chigogo.

Eight specimens, of which three only were taken by the writer's collectors, from Mkata River, Gulwe, Suna, Gwao's, Mlewa's, Sagayo.

The largest male measured 740. 290. 190. 100 mm., and female 680. 295. 150. 102 mm.

Both of these came from Sagayo, and their stomachs were full of hyrax fur and meat, whilst one had some larger carrion also. The Mlewa specimen had grasshoppers and several large black scorpions (*Pandinus cavimanus* Poc.) in its stomach. It would be interesting to watch a jackal's method of attacking a scorpion. The Mkata specimen's stomach was well filled with the fruit of a tree called by the natives "Mkongo." We came to several of the trees, and amongst the abundant fruit lying on the ground was a good deal of spoor of jackal and civet.

Twelve fleas (*C. felis*) were taken from one jackal.

LYCAON PICTUS subsp.

Mbwizi in Kikami and Kisagara, Iminzi in Chigogo.

The Hunting Dog was not collected nor even seen by me, though it is only too common in the Kilosa District, and was often heard. Whilst I was away from home on one occasion a pack of dogs drove a bushbuck right through the lower part of the house at 6 a.m. Another time they harried a bushbuck past the front of the house at 5 p.m., and Mr. D. W. Bisshopp shot one of the dogs from the verandah, but it was not found for three days afterwards, when it was too far gone to preserve. At Myombo, some nine miles south of Kilosa, they pulled down a bushbuck almost on the doorsteps of a settler's house in the middle of the morning. It is interesting to note that bushbuck appear to run to a human habitation when pursued by their remorseless foes.

Otocyon virgatus Miller.

Bee in Kinyaturu, Bele in Kiramba.

Five males (two being cubs) collected at Mdjengo's, Mtali's, and Sagayo. A score were seen at Izikisia in the moonlight.

The largest male measured 556. 275. 120. 95 mm. One cub died a month after I got it, perhaps it would be six weeks old when it measured 290. 115. 90. 70 mm. Its twin brother was measured whilst alive as accurately as possible at five-and-a-half months old: 470? 250? 120? 94?; he then weighed 6½ lbs.

The two lively little cubs, with eyes open and just able to walk, were brought me at Mtali's on 20. x. 21, their father having been killed by a native dog. At this stage their fur was very woolly and an almost uniform smoky-grey.

At five and a half months the colour was as follows:—Grizzled buff, a thick woolly underfur of buff, almost concealed by long whitish hairs tipped with black. Feet as far up as the knees, black; the whole leg is darker than the body. Tip of tail black, extending in a wedge-shape on dorsal aspect almost to root of tail. Muzzle black, extending on the forehead to between the eyes, on the cheeks to beyond the eyes. Tip of the ears and for some distance downwards, black. The ears are fringed with long all-white hairs, a good deal of buff about the base of the ears.

When young I gave them a great deal of meat; one of them ate a green locustid at three weeks old. Another time Kip, as the survivor was called, pounced upon a Striped Hawk-Moth, chewed it well, dropped it, and then ate it up. He is passionately fond of butter and honey, will eat porridge, bread, eggs, and drink milk or tea with relish. Bananas and paupau are also eaten readily, but he will not touch mangoes or pineapple.

He spends a good deal of his time turning over stones in search of millipedes, which are gobbled up greedily. I offered him a black-and-yellow polydesmid which he pawed over for some three minutes, but would not eat it. In strange contrast was his attitude to a Lesser Stink Ant (*Paltothyreus tarsatus*), which came out of its hole and waved its antennæ right under Kip's nose. He looked at it, then seized and crunched it up despite the smell, which was noticeable to me standing a couple of feet away.

A very big baboon came up to the kitchen one afternoon, and aroused Kip's curiosity, the fox then being five months old. He followed the baboon with his head down, and when the baboon, catching sight of me, cantered away, Kip flew after it for two hundred yards with only about six feet between. A month later baboons were in the vicinity of the house daily, and on several occasions I saw him playing with them. He will lie crouched upon the ground, and a big dog-baboon will come walking slowly towards him till within two yards, when Kip will spring up and fly straight at it, the baboon cantering easily away, looking over its shoulder at the small animal which it could so easily kill. Many other baboons will be close by during this play.

Kip's attitude to baboons is very strange seeing that he is naturally a timid animal, very nervous of approach, especially when feeding. Like many animals he developed an antipathy to natives, which was difficult to understand as they were very fond of him, but at four months old he took to menacing them, snarling and growling and looking very wicked. Even when furiously annoyed at being tied up for the night his teeth scarcely break the skin.

He was six-and-a-half months old when he met his first dog—a quiet little mongrel Dachshund which accompanied a visitor. Kip advanced growling and bristling towards the stranger, and exhibited for the first time a large rufous patch on the base of his tail (dorsally).

MUSTELIDÆ.

MELLIVORA CAPENSIS Schreb.

Kibakusi in Kikami; Nyergeri in Kisagara, Kisukuma, and Kiswahili.

The Honey Badger or Ratel is not often met with in East Africa, though probably fairly common and certainly very widely distributed. Four specimens were obtained from Makindu, Wami River, Kilosa, and Sagayo, those from the last-mentioned locality being skins without skulls, purchased from a native. A young male measured 480. 160. 105. 30 mm., an adult 770. 198. 130. ?? mm., and a female 670. 200. 112. 30 mm.

The immature male was one of two individuals encountered on the plains about 7 a.m. one morning, and shot by my native collector. It appears quite common for them to hunt in pairs, which need not necessarily be of opposite sexes, for two adult females were hunting in company on one occasion.

During July 1921, a native complained that an animal had dug into his strongly-built mud and wattle chicken-house, and taken four fowls. I set a gun-trap (·22 B.S.A.) over the entrance it had made, and the following night the gun went off, but so did the animal without leaving any trace of being hit. A few nights later it returned and took three more fowls in one night, effecting an entrance by digging in a different spot. In neither instance was a trace of the fowls left, and presumably they were carried off whole.

A lion trap was set inside the yard at the spot where it had broken through the fence, and the following morning my boy informed me that a ratel was in the trap. The poor beast had dragged the heavy trap twelve feet and torn a hole in the fence, but couldn't get the trap through. It had chewed a ground-sheet to rags as well as other things within reach, including its own foot, whose claws I recovered from its stomach after having shot it. I have known this happen in the case of another ratel, and have little doubt that in the fierceness of their rage at being caught they lose their sense of pain to some extent, else how could they mutilate themselves?

The stomach of this individual contained fowl feet, beaks, eyes, etc., and the wing of a bird. The other specimen had a little grass, probably seized after capture. A screw-worm and a tapeworm were found in the abdominal cavity.

Despite the nauseous stench of the creature, Wazigoor and Wabeni porters asked for the bodies of two ratels and ate them!

Ictonyx striatus albescens Heller.

A single female Zorilla (250. 152. 49. 23 mm.) was purchased from a native, who had killed it in his fowl-house at Usshora, 30. x. 21. Though very young it had minute fœtuses *in utero*.

Aonyx capensis helios Heller.

Fisi maji, its Kiswahili name, is commonly used for the Otter by both Wakami and Wasagara.

A single female (762. 485. 132. 25 mm.) Otter was trap-shot with a ·22 rifle whilst under water at Tindiga, 1. ix. 22. There were fish in its stomach and a new Ascarid (*Clœoascaris spinicollis* Baylis), and I was somewhat surprised to find a flea (*Ctenocephalus felis*) in the fur of such an amphibious creature. Ticks were also present but not preserved.

Viverridæ.

Civettictis civetta orientalis Matschie.

The Civet is known as Fungo in Kiswahili, Kikami, and Kisagara.

Twelve specimens from Wami River, Mkata River, Kimamba, Kilosa, and Sagayo.

The largest male measured 900. 480. 140. 60 mm. (Sagayo), and female 940. 445. 140. 60 mm. (Wami R.).

The only note on breeding is the record of two litters brought me on 21. iii. 21 and 29. xi. 21 from Kilosa. The first litter contained three and the latter two. The young are almost black.

The first batch were very fierce, spitting and biting when approached; after a month two of them showed signs of taming, and would come to me at meal times, standing up on their hind legs or clambering to my knee. They never liked being handled. Civets are very dirty feeders, and these little beasts invariably put their feet into their milk or held jam down with their paws, getting into a nice mess. They were very fond of mangoes.

Stomachs of wild specimens held the following:—(i.) Bodies of birds and rats skinned by my collectors the previous day, chicken's leg and mango skins from the kitchen. This animal was shot at 5 a.m. in bright moonlight from the verandah. (ii.) Flesh of a baboon, which I had put out as a bait, some other big pieces of flesh, skin bearing fur of what might be the gerbil (*Taterona* sp.), a locust, and a calculus of hair. (iii.) *R. c. microdon*, eggs and chicks of a francolin, fruit of mkongo tree.

On offering the body of a skinned genet to my young civets they approached it gingerly, and then the male flung himself, throat foremost, on the carcass, rubbing his throat, chest, and shoulders in the entrails in an ecstacy of delight; he was shortly joined by a female, and the two of them pushed the carcass all about the floor in their efforts to rub their throats upon it.

After a month in the house I turned these three civets loose in an empty room of a roofless German house, and as I was unable to spend much time with them they grew very fierce, though regularly and well fed. After four and a half months, therefore, I chloroformed two of the worst and let the other go. The two chloroformed, which may be assumed to be five months old, measured: Male 520 310. 97. 46 mm., weight $5\frac{5}{8}$ lbs. Female 580. 350. 110. 50 mm., weight over 7 lbs. (the scale only weighed to seven). This male was always rather backward.

The liberated male had his food placed in the room and returned for it regularly for a fortnight, after which I went away. I frequently met it on the path in the moonlight, making its way to the house, and it did not flee but generally withdrew in a shadow and crouched there until I passed.

Few animals are so rich in parasites: one specimen alone had nine hippoboscid flies (*H. capensis* v. Olf.), fleas (*Ctenocephalus felis*), ticks (*Rhipicephalus simus* Koch), and nematodes (*Filaria* sp., all females, not *F. martis* Gmel.) were found in its stomach. Ticks and this species of flea were almost invariably present. Another flea (*Echidnophaga larina*) and tick (*Hæmaphysalis leachi*) were found on a Sagayo civet.

Two instances of civets caught in gin-traps biting off their feet came to my notice, indeed I found what was probably the remains of one of them in a dry watercourse. The skull showed that the animal was very aged, all the molars on the right rami of the mandible were missing and the bone healed over, though it appeared to have had a bad abscess at one time.

The bodies of civets killed on one safari were eaten by my Wazigoor and Wabeni porters.

GENETTA DONGALANA NEUMANNI Matsch.

Nghanu in Chigogo, Ndele in Kinyaturu, Nilele in Kiramba, Kanididi in Kinyamwezi.

Nine specimens of Neumann's Genet were obtained at Kidenge, Itumba (skin seen), Ndogwe, Suna, Singida, Mdjengo's, Mtali's, and Izikisia. Three of these were trapped with a down-pointing ·22 rifle while attempting to get at a fowl used as bait.

At Singida an adult male (490. 460. 90. 50 mm.) was brought to me alive with a string round its neck; though freshly caught it allowed itself to be stroked and was very amenable, possibly it was dazed by daylight. When annoyed it raised the fine black dorsal mane on end and bushed out its ringed tail.

At Izikisia on 15. xi. 21 two kittens were found in a hole in a tree in open miombo bush country. The hole was some ten feet from the ground. I rather hesitate in referring these kittens to this race as no adults were collected in the locality.

A rat (*R. c. microdon*) was found in the stomach of the Ndogwe genet. These genets cause a great deal of mischief among native fowls, which they appear to kill for killing's sake when they can get into a fowl-house.

GENETTA SUAHELICA Matsch.

Kanu in Kiswahili, Kikami, and Kisagara, Tondolega in Wahehe.

Thirteen specimens from Mkata River, Rudewa, Kimamba, Kilosa, Mbonoa, and Mdjengo's.

The largest male measured 500. 440. 89. 45 mm., and best female 525. 435. 87. 48 mm.

Two very young kittens (♂ ♂. 190. 165. 40. 25 mm.) were brought to me at Kilosa on 7. v. 21, but only lived till 20. v. 21. Another, only a few days old, on 28. iii. 21, throve for a month, but during my absence from home was allowed into a room where there was a freshly-cured leopard skin on which it went to sleep. It afterwards apparently licked the skin, for I found traces of arsenic in its stomach, and it died with all the symptoms of arsenical poisoning on 27. iv. 21.

It was suffering from constipation when brought to me and on the second day extruded its bowels, which I washed with warm water and permanganate, lubricated with vaseline, and returned. I gave it doses of salts at 2 and 6 p.m., and it obviously recovered as it lived for a month after and was always very full of life.

I first fed it on sweetened milk and jam; after nine days I gave up feeding it, and it lapped milk and it attempted scraps of meat. It very soon gave up spitting when handled, and showed no fear of a mungoose or three young civets, ever so much larger than itself. It spent a great deal of time in sleeping, varied by climbing, at which it was an adept. It clambered up the mosquito gauze to the top of a door and then called to be helped down; backs of chairs were a very favourite goal, which when reached it would rest upon.

When sitting up in trees at night it is a common occurrence to hear genets hunting through the grass, pouncing here and there, or clambering into a bush, from whence birds would go off with a twitter or a whirr according to kind. I waited for one such for half-an-hour before it appeared in the road. After one or two short runs it then vanished, but presently reappeared, and seeing the goat beneath my tree dashed towards it, but on the far side, where it halted for a second to look at the goat, and I shot it dead.

In its stomach were grasshoppers, a large black field cricket, and beetle elytra, together with not a little green stuff, mostly grass-blades as far as one could determine. A second individual had eaten a gerbil (*T. swaythlingi*) and a rat (*R. c. microdon*). In the stomach of another was the tail of a rat, the unidentifiable foot of a small bird, the body and limbs of a frog (*Rana* sp.), and many kinds of insects much chewed. Yet another held a single rat (*R. c. microdon*).

Three species of flea were taken from three individuals (viz., *Echidnopsis gallinaceus*, *Chimæropsylla potis*, and *Ctenocephalus felis*). Ticks (*Hæmaphysalis leachi*) were found on three genets, and nematodes (*Ascaris* sp., females) were also taken.

GENETTA STUHLMANNI STUHLMANNI Matsch.

Nilili in Kisukuma.

A single immature male (240. 230. 80. 33 mm.) twelve feet up in a bush on the banks of the Simiyu River at Sagayo in mid-morning. Fleas (*Ctenocephalus felis*) and ticks (*Hæmaphysalis leachi* var.) in its fur, and ascarids came wriggling from its mouth just after death. These worms were all females and not referable to *Belascaris*, but may indicate a new species (Spaul). Adult genets were seen in the neighbourhood of kopjes on two occasions.

HERPESTES (CALOGALE) FLAVIVENTRIS Matsch.

On three occasions examples of this Mungoose were seen hunting in daylight on kopjes at Sagayo; they reminded one strongly of ferrets in the way they explored crevices and reappeared in unexpected openings.

♂. 350. 280. 52. 20 mm. ♀. 332. 260. 25. 15 mm. The male had eaten a rat (*R. c. microdon*); the female, which was gin-trapped among the rocks, is in the Game Dept. collection.

HERPESTES (CALOGALE) GRANTI Gray.

A female from Usshora had been killed by a native in his fowl-house. I saw one of these mungoose in association with *H. g. lademanni* Mats. in a ravine at Mbulu's, another day a pair were hunting together over a rocky kopje. What I took to be a male had a black tail-tuft, not ochraceous as in the female.

♀. 350. 290. 60. 20 mm. It had three fleas (*Ctenocephalus felis*) in its fur.

HERPESTES (CALOGALE) MELANURUS RUFESCENS Lorenz.

A male killed at Zanzibar on 12. viii. 16 was presented to the writer by Dr. Aders, F.Z.S.

HERPESTES (CALOGALE) GRACILIS LADEMANNI Matsch.

Known as Kiniboo in Kinyaturu, and Chonja (?) in Kisukuma.

A single male (350. 280. 60. 30 mm.) from Mbulu's was driven by my collector out of a ravine between kopjes in thorn-bush steppe. Two were seen on different occasions at Mtali's and yet another at Mkalama, but they are very active and vanish from sight amongst the boulders of the kopjes which they frequent.

The male's stomach contained a lizard (*N. emini*), a skink (*Mabuia* sp.), a chameleon (*C. parvilobus*), and grasshoppers. There were also some indeterminable nematode parasites. Six fleas from the fur were identified as *Ctenocephalus felis*.

HERPESTES (CALOGALE) GRACILIS IBEÆ Wroughton.

A female was collected at Ngong Forest, Nairobi, 2. x. 20.

HERPESTES ICHNEUMON FUNESTUS (Osg.).

Four from Kilosa. Two were purchased from natives who had killed them in their fowl-houses. A skin was also seen at Mkalama.

One male (532. 532. 100. 37 mm.) was very lean, but its fur was in good condition, some of the black hairs in the terminal tail-tuft were six inches long. There was rat's fur in its stomach.

There were many parasites on this one individual. Lice (*Trichodectes rammei* Stebbe) swarmed in thousands. Of nineteen fleas captured two were *Echidnopsis gallinaceus* and the remainder *Ctenocephalus felis*. Nematodes from the liver and intestines were *Physaloptera* sp. indet.

ATILAX PALUDINOSUS RUBESCENS Holl.

Karasa in Kikami.

Six specimens of the Water-Mungoose from Bagilo, Tindiga, and Kilosa.

The largest male measured 530. 350. 105. 35 mm. Largest female 530. 330. 100. 31 mm.

The latter, taken at Tindiga, held two fœtuses measuring 104. 52. 21. 5 mm., and both together weighed 3 oz. (27. viii. 21).

One was shot at 8 p.m. in bright moonlight as it approached a dead monkey I had left on the path, a second appeared shortly afterwards.

One specimen swarmed with lice (*Trichodectes acutirostris* Stebbe, *T. mungos* Stebbe, *T. ? rammei* Stebbe), a tick (*Rhipicephalus simus* Koch), and had filarid worms beneath the skin. In the stomach of another was an ascarid (*Clœoascaris spinicollis*, gen. et sp. n. Baylis).

ICHNEUMIA ALBICAUDA IBEANA Thos.

Kanhanga in Kikami, Mbaku in Kisagara.

Six specimens of the White-tailed Mungoose from Tindiga, Ilonga, Kilosa, and Nairobi.

The largest female measured 600. 455. 132. 38 mm. An immature female (440. 350. 100. 38 mm.) was disturbed in the burning of rubbish and run down by a native, from whom I purchased it. It is very dark in colour and the white hairs of the tail are concealed by longer blackish ones, so that it presents a very different appearance from the typical white-tailed individuals.

A female killed at Tindiga on 10. ii. 21 had two fœtuses, those on 18 and 24. viii. 21 none.

On 1. i. 23 I was given a young male by Capt. Turnley, at which time its coat was grey and very woolly, but long black hairs were showing thickly on the nape and fore-parts.

It liked being picked up and petted and would lie on its back in one's arms most contentedly. When very pleased it licked one after the manner of a cat. One's nose seemed to be a cause of offence, for if lying on a sofa or in any position where it could be reached, the mungoose would attack it fiercely. With this exception, it never attempted to bite except in play.

It enjoyed a game—usually started them in fact. One favourite pastime—after having located a safe retreat under a cupboard or other piece of furniture—was to steal forth with the greatest caution, then, feigning alarm, to scuttle and scramble back with much noise. After repeating this performance several times in the hope that you will chase it back, which it considers great sport, and failing to attract your attention, it will approach very silently and bite your heel or give you a pat with its claws and then tear madly back to its retreat. If you still refuse to come and play, it attacks your shoe-laces and 'rags' them with great abandon.

It showed great alarm of sudden noises, and the hairs of its white tail immediately stand on end as does its back fur to some extent; it spits most explosively. It has a wonderful variety of sounds at its command, one of contentment is almost indistinguishable from that made by the young Blue Monkey, and is something like 'urrr.'

After I had had it two months I went on safari, and almost the first night it was turned loose in the tent it was scared by the sudden entrance of a native and ran out into the bush, never to return.

It showed great fondness for the pupæ of moths and wasps, and broke open the mud nests of the latter with its strong claws, but never in my experience touched the grubs. It often rejected the bread in its bread and milk, but liked sweetened condensed milk and eggs. Chicken bones would be picked clean and greatly appreciated. Rice, mashed potatoes, and porridge were taken readily.

The stomachs of the wild adults collected contained the following:—(i.) Grass, leaves, termites. This individual was trapped whilst attempting to enter a fowl-house. (ii.) Remains of fowl, crickets, paupau skin. (iii.) Grasshoppers. (iv.) Termites.

Fleas (*Ctenocephalus felis*) and ticks were found in the fur, and cestodes (*Spharganum* sp.) between skin and flesh. Two individuals had numerous screw-worms in viscera.

HELOGALE UNDULATA UNDULATA Peters.

The Lesser Mungoose is known as Kimgalla in Kisagara, Muloli in Chigogo, Minyirsira in Kinyaturu.

Five specimens collected at Kipera, Mpanira-kwa-Sagoi, and Mbulu's. It was also clearly seen near Mkata River, Pooma.

The species is diurnal and very definitely associated in my mind with the termite hills, to which the little hunting parties scamper when disturbed. Before disappearing down the holes they usually sit up, with fore-paws drooping on their stomachs, and take one more look at the cause of their fright. One was shot on a sloping tree-trunk.

Largest male measured 240. 175. 45. 17 mm., and female 230. 170. 45. 19 mm.

HELOGALE VICTORINA Thos.

Kamsio in Kinyamwezi, Lonzi in Kiramba, and Kijinolo in Kisukuma.

Eleven specimens from Mdjengo's, Sanga, and Sagayo. It was also seen at Mlewa's, Mtali's, Mkalama, Usurwe, and Shanwa.

Largest male 260. 160. 43. 20 mm., female 245. 157. 45. 18 mm. Young of latter in nest 80. 40. 15. 4 mm.

One individual held two fœtuses only (Sanga. 16.x.22). A slight nest of grass (native collector's statement) was found in excavating a termite heap, where the female was found with four almost naked young. She and her family were transferred to a box, but though eating heartily herself, she refused to feed them so that they died (Sagayo, 1.xi.22).

Stomachs contained finely masticated insect remains, which appeared to be chiefly those of grasshoppers.

MUNGOS MUNGO COLONUS (Heller).

The Banded Mungoose is known as Ngutchiro in Kiswahili, but the Wa-swahili use this name for all other species of mungoose which they may encounter and many of which are quite unknown at the coast. The Wasagara appear to have no other name than Ngutchiro for it. Tukwa in Kikami, Nghalasanga in Chigogo, Kala in Kinyaturu, Kala in Kiramba, Ikala in Kinyamwezi, Nhala in Kisukuma.

Five specimens collected at Dodoma, Pooma, Mdjengo's, and Usshora. It is, however, a very widely distributed species and was also seen at Mlewa's, Mtali's, Usurwe, Mkalama, Shanwa, Sagayo, and all along the road from Ulugu to Tabora. Curiously enough, I have never seen it at Kilosa during the two years spent there, though a company of mungoose crossed a path one afternoon, but at too great a distance for me to be sure they were not Atilax (which usually goes singly or in pairs), or some other large species.

Largest male measured 390. 240. 78. 25 mm., and female 395. 280. 82. 20 mm.

At Pooma I saw ten of these mungoose sitting erect on a termite hill, intently watching a flock of guinea-fowl which were feeding towards them across the open, the nearest being only twenty feet away. I was able to approach and shoot two mungoose sitting close together, but one fell down the hole. The other I found was a very light sandy, or straw colour, excellently adapted to life in the thorn-bush steppe. On showing it to my collector, he said that this variety was well known and that probably all in the thorn-bush country would be of a similar shade. Unfortunately for this theory, its dead companion was dug out of the hole and was the typical nut-brown shade, as were all the others subsequently seen at close quarters in the thorn-bush steppe.

Just on the outskirts of Tabora, about twenty feet from the mainroad along which a noisy stream of natives were passing, eight mungoose were seen sunning themselves in all manner of indolent attitudes about 7 a.m. They took not the slightest notice of my porters, who had dropped their loads, and were moving about within fifty feet of the bold little beasts.

An amphisbænid (*G. modestus*) and two skinks (*Lygosoma* sp.) were found in the stomach of an Usshora specimen; a grasshopper, large carabid, and beetle larvæ in another.

Fleas (*Echidnophaga gallinaceus*) were taken in the fur of one, whilst screw-worms were found in the viscera of another. The Banded Mungoose is killed by the Wanyaturu for food.

PROTELEIDÆ.

PROTELES CRISTATUS TERMES Heller.

I have not been fortunate enough to obtain a specimen of the Aard-wolf, but the creature being so rare in Tanganyika Territory it seems worth recording every occurrence. I have only seen two skins, one obtained near Itumbi in Manyoni District, the other, which is in the Game Dept. Museum, was obtained by Mrs. Billinge at Kiganga on the Ruaha, 31. viii. 22.

It was caught in a lion gin set on a path and was a full-grown male, measuring 30 inches from nose-tip to base of tail, the latter being another 10 inches according to Mrs. Billinge's measurements. She estimated the weight as about 20 lbs.

HYÆNIDÆ.

HYÆNA HYÆNA SCHILLINGSI Matsch.

Two examples of Schillings' Striped Hyæna were obtained at Gulwe and Mtali's. Both were males, of which the larger measured 1190. 290. 200. 153 mm.

In the stomach of the younger specimen were the remains of a monkey skinned in camp that day, a great quantity of mealies, and some wild yellow fruit which might have been in the stomach of the monkey. There were also a lot of vertebræ of a good-sized python and the skin of an agama lizard.

A Hippoboscid fly (*H. capensis* v. Olf.) was in its coat and also two species of ticks.

CROCUTA CROCUTA GERMINANS Matsch.

Three specimens of the Eastern Spotted Hyæna were collected, others were also examined from the following localities:—Kilosa, Mtali's, Izikisia, Simbo, Shandwa, and Mwadira.

The Kiswahili name of Fisi seems to be universally employed, in Chigogo it is altered to Mvisi, and in Kisungwa it is called Fifi.

The largest male measured 1350. 250. 215. 110 mm., the largest female 1245. 241. 215. 101 mm.

The latter held a single fœtus very near the birth, weighing 3¼ lbs. and measuring 330. 70. 60. 29 mm.

One which I shot at a waterhole at 1.30 a.m. had come to drink earlier in the evening, and a movement of mine in the hide-up had caused it to bolt. It returned with three zebra at its heels, and tried to get past a flanking zebra without coming too near my hide-up, which it was quite aware was tenanted. It was in abject terror, trying to crouch past with stomach close to the ground, when I shot it at fifty yards.

The contents of its stomach and others were as follows:—(i.) Goat's skin, hoof and ox bones, broken fragments of a gourd picked up near a native hut presumably. (ii.) Goat or small buck's hoof, giraffe bones and strips of giraffe skin, pared off by a sandal-maker, fowl's feet, bits of gourd. (iii.) Remains of goat and ox, wild pig, duiker, rat's foot, fowl's feet, and two hairy calculi.

Three fleas from the last-named specimen proved to be *Ctenocephalus felis* and *Echidnophaga larina*. Hippoboscid flies (*H. capensis* v. Olf.) were found on two specimens, also ticks (*Rhipicephalus simus* Koch).

FELIDÆ.

ACINONYX JUBATUS RAINEYI Heller.

Duma in Kikami and Chigogo. Pocho (?) in Kisagara (Pocho appears to be applied to the Hunting Dog and there may be some confusion). The Cheetah is not a common animal in Tanganyika Territory as it is in Kenya so far as my experience goes. The natives are unfamiliar with it and few seem to know its name, usually confusing it with either the Leopard or the Serval!

The only local skin I have seen was of quite a large animal, which was brought for sale by two natives, who said they had found it dead near Kideti (viii. 22); having been killed by a snake which, after an examination of the skin, I think very probable; most likely a puff-adder.

The Wanyimwezi, Wanyiramba, and Warangi have a saying that the witch doctors give a potion to the cheetah which endues it with sufficient courage and fierceness, and causes it to rush off into the bush, where it lies in wait for children and even adults whom the witch-doctor wishes to be rid of: the creature pounces upon them, lacerates them, and laps the blood, but does not eat the flesh, and presently leaves the body.

Felis leo massaica Neum.

One specimen collected at Kilosa. Many others seen; the distribution is so widespread in Tanganyika Territory that it would serve no useful purpose to give localities.

Manes as a guide to subspecies? Some lions broke into a hut 300 yards from Kilosa Boma on 4. ii. 22 and killed four goats: traps baited with dead goats were set the following night and one lion was killed; the other, wounded in the nose, is the "specimen" referred to above. This individual had a fine dark mane, and was a full-grown male in its prime with splendid undamaged teeth. The other was a very old male, maneless, with worn and broken teeth, very ill-nourished, and with the spotting usually associated with youth or females, very noticeable.

Do lions climb trees? At Kipera on 26. xii. 22, I was coming through a lot of rank sedge almost shoulder-high when I saw a fine waterbuck on a slight eminence some two hundred yards away. I fired, and the bullet struck a tree close behind him and just below his head. I fired again, and he went down with a roar. At the same moment a lioness sprang from a tree and bounded away in full view to a thicket. My boys, who were some little distance behind me, said that at the first shot they saw the lioness put her head out of the foliage and peer about, and they supposed I was firing at her, but with my attention rivetted on the buck I never saw her till she sprang from the tree. An examination showed her claw marks, and I think she was at a height of 12 feet from the ground and about 10 feet from the buck, upon which she was doubtless just about to spring. The tree was not quite vertical, and the part she was sitting on was almost horizontal.

It is often said that only old toothless or injured lions turn man-eaters! The following incident is a good commentary. A native woman at Tindiga, a few miles from Kilosa, venturing outside her hut 8. ii. 21, was sprung upon by a lion and eaten in the mealies scarcely 50 feet from the hut. On 11. ii. they visited a cattle boma and paraded round and round it. On 12. ii. they squatted one on each side of a jumbe's door, as was evidenced by their spoor; they then went off and pounced for a man's foot through a reed wall: the occupants scared them off by making a noise. On 13. ii. one of them tore out a bundle of grass from the side of a hut in an effort to reach the occupants, who also scared them off with an outcry. On 15.ii.21 we heard their persistence had been rewarded, for they killed a man at Kivungu and ate him except for the head. They appeared to be changing their beat and making towards Myombo, where they mauled a man a fortnight ago who was rescued by his friends.

A scout had been sent to Kivungu to set traps and was in a hut, when the door was burst open by a lion: a woman was sleeping close to the door. He ran outside and saw the lion standing not twenty feet from him, but could not fire as it was in line with another hut. On 17.ii. they broke into another hut at Kivungu, five hundred yards from the one forced the night before. The only occupants were a woman and child, and she scrambled to the flimsy reed shelf above the door and screamed. She told me that the lion stood in the doorway but was afraid to enter. The neighbours then beat tins and lit torches, so that she was able to run across to an adjacent hut. When they had gone to sleep and all was quiet the lions returned, dragged out the bed to the edge of the clearing sixty feet away and ate the plaited cords, which doubtless reeked of human beings, and smashed up the framework, which I myself saw early the following morning.

On 18.ii. they broke into a hut between Kivungu and Myombo and dragged out a basket of beans and ate the basket; they then crossed some five miles of country to Tindiga, broke into a hut there, and nearly got a man. On 19.ii. one of them entered a hut before it was dark—they were obviously hungry—it was frightened off and a trap set, which caused its death at dusk when it returned. Its companion entered a second trap a few hours later, and the man-hunting automatically ceased.

I measured these lions carefully and independently, and found them exactly alike with the possible exception of a half-inch difference in the length of ears. Both were tawny, maneless males in well-nourished condition, presumably brothers of the same litter. The one had the remains of a wild-pig and some grass in its stomach; the other had nothing but some parasitic worms. Length of head and body, 67 inches. Tail 31 inches.

Another instance of man-killing occurred on the night 8–9.v.21, when a lioness appeared to have become desperate from hunger. The circumstances as I reconstructed them from the spoor and native statements were thus:—The lioness first appeared (unseen), in some rank grass outside a native kraal, where it crouched, wriggled about, and watched a large party sitting around a fire inside the stockade. She then rose up and, with a "woof, woof," trotted through the doorway and seized a youth of fourteen by the thigh, and started back for the doorway. The jumbe, who was a very old man and decrepit, pursued the lioness, striking her with his bare hand on her quarters as she made for the doorway—the compound was an unusually large one. When she reached it the body stuck crosswise, and after a couple of attempts and with the persistent old man still spanking her, she dropped it, sprang over it and made off. The boy was quite dead. I could see very few marks on the body except where she had carried him in her jaws.

She then crossed the piece of waste land and came out on a path where she clawed up the ground considerably, presumably to clean her claws, or in a fit of annoyance. She followed the path for half-a-mile, then cut across another fifty yards of rank weeds, and came to the edge of a little clearing where a woman was sitting under the eaves of her hut shelling maize into a dish; her baby was slung on her back. Again the lioness lay down, to take her bearings I suppose, then sprang upon the woman, whom she carried off to beneath a tree fifty yards away. The woman screamed, and beat the lioness about the face with her bare hands; neighbours seized firebrands, tins, etc. with which to make a noise, and sallied forth. They caught sight of the lioness crouching over the woman beneath the tree, where it had, without doubt, taken her to eat; at the sight of the rescue party the lioness bolted. This was about 7.30 p.m. The baby was unhurt, the mother horribly mauled.

The animal next made for Kilosa, and on reaching the village of Mkwatani broke into a hut where two women lived together. It smashed down the door, which was only made of matama stalks, dragged the body ten feet from the door and ate half of it. There were six other huts within a hundred yards, and when the neighbours rose next morning they caught sight of the lioness crouching over her prey, she also saw them and cleared. A messenger brought me the news soon after daybreak, and I sent him back with instructions on no account to move the body. I set off on my cycle, and when close to Mkwatani another native met me with the information that the lioness had returned in bright sunshine at 8 a.m. and carried the body off into the matama. I followed the trail (which was well marked with various items such as a bit of gory rag, some toes, bits of fat and the like) for a hundred yards, when the matama became so thick one could not see ten feet away, and had perforce to make considerable noise in forcing our way through it, so we returned—the boys to make traps, while I went on to investigate the other "kills" already referred to. At 5 p.m. an askari on his own initiative wormed his way up to the lioness as she was feeding under a mango tree, and riddled her with bullets from a few feet away.

A Hippoboscid (*H. capensis*. v. Olf.) was taken on one specimen.

With Lions at their Kill.

One morning, in October '21, I was sitting some fifty yards from a water-hole, when I noticed a little group of animals wending their way through the thorn-bush towards the water, from which they were still a hundred and fifty yards. At the first glance I thought that they were a little group of buck, but a second later saw that the leader was a maned lion, followed by another full-grown and four nearly full-grown cubs. At the first shot these made off, but concluding that they must come to water some time, I had a little stockade—perhaps ten feet long by five feet wide—constructed between two small trees about fifty yards from the water. At 4 p.m. in the afternoon I took up residence in this little cage and awaited events.

All was very peaceful except for some fifty or more doves assembled around the water-hole; at intervals of ten minutes these took fright and with much clatter flew to the surrounding trees, but soon returned to the waterside. A large flock of guinea-fowl fed up to within fifteen feet of our hiding place. Little else occurred to break the monotony of our wait until 6 p.m.: three fine eland, but with very average horns, emerged from the thorn-bush scrub and came within fifteen to thirty feet of the hide-up, the nearest was certainly not more than fifteen feet away. The boy had set two gin-traps by the water's edge and had been told to remove the pins, which he said had been done: fearful lest the antelope should get caught in these, I scrambled up the palisade (some nine feet in height), shouted, shoo'd, growled and wildly waved my arms in an effort to scare them away. The stupid creatures stood stock still for fully two minutes before wheeling and cantering off.

From 7 to 9 p.m. I slept a good deal, though constantly aware of the presence of hoofed animals in the vicinity: these approached the water with great caution and then stampeded, individuals passing within a few feet of our stockade on several occasions. I imagine it was shortly after 9 o'clock (the boy had mislaid the matches, so we could not have a light, even had we desired one) that I suddenly became wide awake with a strong sense of something wrong. A lion was padding round the stockade and snuffling at times; he was within five feet of me, but vainly I sought to pierce the darkness to get a shot. The footsteps would cease, but at what angle to fire I could not decide, and I was above all anxious not to leave a legacy of a wounded lion behind for the local natives, twelve of whom had been carried off by lions in this district in the preceding month. These deaths had occurred for the most part along one stretch of road about twenty miles in length in broad daylight, so that the road was now taboo.

Gradually I realised that more than one lion was paying us attention, as heavy breathing could be plainly heard at several different points, and at times it seemed that some were lying down whilst their companion tried to scare us out. The smell of them was very strong in my nostrils; my companion, who had wept himself to sleep at the prospect of an awful end, still slumbered peacefully. With startling suddenness a loud grunt was given perhaps twenty feet away, it was followed immediately by a noise of animals rushing straight towards us. I waked the boy just as I was able to distinguish the hammer of hoofs, and a herd of eland came sweeping down the hillside through the thorn-bush in a most reckless manner. The lions lying on either side of us, however, rose up and headed the mob with grunts, so that they wheeled at exactly twenty feet from our hide-up and swept on with the magnificent abandon of a cavalry charge.

Confused noises about a hundred yards further on followed by a roar (such as I have heard a felled bullock in a slaughter-house give), announced that an eland had been downed by other lions lying in wait, whilst the remainder of the herd crashed away through the scrub. Right on the heels of the herd as they passed us came at least three lions, whose easy swinging gallop sent a shiver down my spine; they passed so close that we could hear them panting, and on reaching the kill they made a variety of noises, mostly grunts of satisfaction. Then one gave two roars, which were answered by lions grunting all up the valley.

I was greatly impressed by the splendid organization of the drive—lions posted all along the valley to head the herd off. The final coup from the signal grunt to the roar of the beast, which had been sprung upon us, was scarce a minute, I should imagine, and took place with such a startling suddenness after the former silence that it rather put one's nerves on edge. They soon began rending and feeding upon the carcass in a very amicable way to the accompaniment of many small sounds, which made me think that they were really a great deal nearer than was the case, for daylight revealed the kill between a hundred and a hundred and fifty yards off, so that I concluded the animal must have carried its lion for the best part of fifty yards after it was sprung upon—and what a beast it was! A fine female eland, with horns $27\frac{5}{8}$ inches long (front-edge measurement), heavy in calf, which must have been very near birth to judge by its hoofs, which were all that remained of it. All the meat excepting the head and legs had been eaten, the legs being still attached to the skin with some of the backbone and broken basal portions of the ribs.

To return to the lions, however. Following the roars and their replying grunts, came the lions themselves in ones and twos, grunting all along the way, and many of them passing close to my place of concealment. Though a gentle rain was now falling they presumably smelt me, for several would pause for a moment before padding on to join their comrades at the kill. What astonished me was their good behaviour, an almost entire absence of growling and snarling, merely the munching, lapping and tearing of food, and the small grunts of satisfaction already alluded to. About an hour later—so it seemed to me, but I may have been wrong—a party went down to the water, which was only fifty yards away, and the sound of lapping was very loud; then some individual found the traps (these were set but the pins not removed), which they growled at and dragged about, together with the heavy tree-trunk to which they were chained, in the most astonishing way. On hearing the continuous rattling of the chains and the growling, we congratulated ourselves on having got one lion at least.

They presently returned to the kill to discuss dessert, and discuss it they certainly did, growling, grunting and snarling as they crunched the bones, which they would drag away and eat by themselves: some walked about and grunted. This disconcerting commotion continued till a couple of hours before dawn: there was one interruption when two lions came along the ridge forming our side of the valley and gave a peculiar sing-song call that I have never heard from a lion before, and strongly reminded me of the cry of a hunting-dog; this was answered by a lion at the kill, which left the kill and walking past us, calling the whole time, joined the others on the ridge above, when they all went off in the direction taken by the mob of eland. I imagine the peculiar cry of the lions was a call to come and join another hunt. Not long after this a lion came back to us and pattered round, lay down and breathed hard. Though we were having occasional flashes of lightning and a good deal of thunder the darkness was absolutely impenetrable, and while listening for further movements on the part of our visitor, I fell asleep.

When I awoke dawn was breaking, but still the light was too poor to see a rifle sight. I jumped up, and crept silently to the side of the stockade nearest the kill. For a moment I saw nothing, then in the grey light I made out a lioness standing with her whole flank exposed not fifty yards away, she was looking towards the water. I turned round and whispered to the boy to hand me the rifle, our quarters being somewhat cramped: in doing so, he made some small sound which caused the lioness to spring round facing me and growl, at the same moment a very small cub came racing up from the water's edge, and the pair of them trotted off immediately and obliquely. I had scarcely time to thrust the muzzle of the rifle through the fence and take a hurried shot after them, before they were lost to sight in the maze of thorn-bush. The boy scrambled up the tree which formed one end of the stockade, and said that he could see a big maned lion making off from the kill, which was hidden from our view by intervening thorn-bush; he was already a long way off, being doubtless startled by the shot. So, after all, we returned to camp empty-handed, but not regretting a very interesting experience.

Felis pardus suahelica Neum.

Two specimens gun-trapped with ·22 at Kilosa. Like the last, the Leopard has such a wide distribution in Tanganyika that to record localities seems but a waste of time.

Native names seem to be generally derived from the Kiswahili Chui; in Kinyaturu, Mui; in Kisukuma, Sui; in Kikami, Duma; in Chigogo, Suwi.

Both the above-mentioned specimens were immature—viz., male 462. 436. 82. 44 mm. and female 1092. 737. 229. 77 mm. A larger male measured 1240. 660. 240. 73 mm., and female 1141. 659. 215. 76 mm.

The latter, being also a comparatively young animal, had only two fœtuses (Kilosa, 20. ix. 22), of which the male weighed $\frac{5}{8}$ pound and measured 217. 110. 42. 10 mm., and the female 206. 107. 39. 10 mm. The coloration and spotting most distinct in front of ears, where hair was quite well developed, spotting (no coloration) distinct all round area between front and hind limbs, both belly and back, also on tail. No spotting on fore-limbs, and only on the outer basal portion of hind-limbs.

At Kilosa the staple food of the leopards would appear to be baboons. Mrs. Turnley was fortunate enough to see a leopard carry off a baboon at 3 p.m., only 200 yards from her house. The baboons mobbed the leopard, which made off towards the hills. By day, however, the baboons are generally masters of the situation. On one occasion, a native reported baboons mobbing a leopard within a quarter-of-a-mile of the house, and on arriving at the place I saw the leopard was 60 feet up a tree. I had two shots but missed, the second striking the limb on which the leopard was crouched among the foliage.

Another time I had sent out two collectors in the morning, when one returned reasonably excited to say that they had heard a great outcry of baboons on the opposite slope of a small rocky ravine, and on going nearer to see what the uproar was about, they saw four old baboons surrounding a leopard and striking at it with their hands; as surely as the leopard turned on one he would be fiercely attacked by those behind, so that he was very much at a loss to know what to do and sought refuge beneath a bush. The one boy had remained to watch the proceedings whilst the other brought the news.

We hastened to the spot, which was fully half-an-hour distant, only to find that there was no boy or baboons there. My companion was inclined to think that they were romancing, but having come so far, he crossed the ravine or donga lower down and went to the place where the alleged fight had taken place, I remained on the near side. He called out that the spoor spoke for the truth of the boy's statement, and easily traced the leopard from the bush to the donga, on the edge of which the baboons had collected and torn up the turf in their fear, wrath, and excitement. My companion said it was obvious that the fight had gone on, as the baboons would not have left the leopard in the donga, but just to make sure, he ordered the boys to throw in a shower of stones. The next minute I called out something, and there was an angry snarl in the bushes on the edge of the donga not ten feet from me, and the grass swayed. The leopard, disturbed by the noise on the far side and the shower of stones, had been coming up when my calling out had turned it. We beat down the grass and found its spoor on the spot where the grass had been set in motion. The donga we subjected to a very thorough search, but owing to the amount of cover the animal got away.

Dogs would seem to be the next favourite article of diet, one was taken off the verandah of a house near mine. At 5 a.m. one morning I was awakened by a very horrid noise, rather like cats quarrelling, but dying away in a moan followed by several other moans. It was only sixty feet from the house, and I ran out with a lantern, but could see nothing.

My neighbour's dog, a biggish animal, was in the habit of coming to this spot on my path to relieve itself every morning, and the leopard had no doubt become aware of this. My boy took up the spoor and traced it for two hundred yards into the rubber plantation, where he found the dog with only one haunch eaten. Mr. C. F. M. Swynnerton sat up by this and saw the leopard as it returned at dusk, but the leopard seeing him also made off before he had time to fire.

Goats make a very effective bait for leopard traps, but on one occasion, the setting of the string being too slack, a leopard was shot dead just as its jaws closed into the goat's skull so that they both died simultaneously, the leopard not even opening its jaws which had penetrated to the brain. Remains of goats were found in the stomachs of several leopards.

Bushbuck are often killed by them; in the case of one old male killed in a donga (21. xii. 20), it could be plainly seen that the leopard had sprung on its back and clawed its throat. It only ate from the haunches, but the next night returned, dragged the body twelve feet away, and made another meal from it. On another occasion a gin was set on a path much frequented by leopards; a female bushbuck was caught in the gin, and the leopard killed and ate part of her. A native going to examine the gin in the morning brought the remains of the bushbuck back to eat himself, but was made to return it. The leopard returned, adroitly avoided both gins which had been reset, and dragged the carcass half-a-mile away up a donga. The boy took up the spoor in pouring rain and came on the leopard, which gave a snarl and made off.

On the Wembere plains I came on two instances where leopards or a leopard had killed impalla; in one case a male, and in the other a female. At Kipera, between 5–11. ix. 22, leopards killed a male reedbuck, a calf eland, and a Lichtenstein's hartebeest in calf, a few days later another reedbuck. In the case of the hartebeest it might have been the work of lions.

At times they will tackle porcupines. An almost full-grown leopard entered a hut at Tindiga, where it was shot by a native, who brought it to me in the flesh. It was in a most frightful condition, covered with sores, from one of which I recovered a broken portion of a porcupine quill. On its neck was a bare patch a foot in length and two inches broad in its widest part; the patch was hard dried skin and may have been made by the leopard clawing at some quill-stumps left in the skin.

This was the second leopard in a hut at Kilosa during the week, for a native awaking to hear something moving about in his hut, jumped up and got a cuff from a leopard as it made off. It had doubtless entered in search of fowls. Two days later, on the same Otto Estate, another man heard something in a bush near his hut, and calling some friends began poking about, with the result that a leopard sprang on him, clawed his shoulders and breast quite unpleasantly, and made off as suddenly as it arrived. I imagine that the man anticipated a bushbuck and surrounded the bush with his friends, so that the leopard acted in self-defence and the man got more than he bargained for.

Unless cornered, or wounded, it is unusual for Tanganyika leopards to molest people. When at Mdjengo's (7. x. 22), the jumbe came to me and said that a leopard, which had been carrying off a lot of fowls of late, had the night before sprung on a sleeping child just inside the door of a hut. The animal dropped the youngster almost immediately an outcry was raised; it seems possible he mistook it for a goat, though I heard of another well-authenticated case where the family were sleeping outside the hut on account of mosquitoes, and a leopard carried off and ate a child. In both instances, the leopards were killed by Game Department Trappers. At Kisanga, in Kilosa District (ii. 22), I heard of a woman who was working in the fields being sprung on by a leopard and so badly mauled that she died shortly afterwards: the leopard was killed by a man who came to her rescue.

Parasites taken from the one young leopard included a fly (*Hippobosca capensis* v. Olf.), fleas (*Ctenocephalus felis*), two species of ticks (*Hæmaphysalis leachi* and *Rhipicephalus simus* Koch), and worms (*Physaloptera præputialis* v. Linst.). The second leopard had nematodes (*Onchocerca* sp. females) in its neck.

FELIS CAPENSIS HINDEI Wrought.

Kizongoduma in Kikami and Kipogoro, Kijongo in Kisagara and Kiswahili, Nzuli in Chigogo, and Nduri in Kiramba.

Four specimens examined from Tindiga, Kilosa, and Sagayo. The largest male measured 900. 300. 158. 80 mm., and female 670. 260. 170. 77 mm.

At Kilosa on 12. vii. 21 some natives cutting grass disturbed a serval, which bolted up a tree leaving a large kitten at the foot of the tree. This was brought to me and commenced to take milk at once, first from a spoon, and then going to a saucer of its own accord. It spat and clawed a good deal when approached, but seeing that it had been dragged along with a cord round its neck, it is not to be wondered at. A month later, however, it was still implacable, rolling on its back clawing, spitting and biting, so I chloroformed it.

One male was trap-shot through the spine with ·22 when attempting to reach the bait of hyrax meat only a hundred feet from my tent. I got up at 4 a.m. without having heard the shot and sent a boy to remove the gun, giving him a lamp. He found the gun had gone off, and stooping over the ground followed the spoor, when (he said) an animal menaced him just as he caught sight of its wounded mate—the lamp chose this moment to go out! He cried out, and came running back very frightened under the impression that there were two leopards. I then went and shot it through the head, it having dragged itself some fifteen feet from the trap.

Its stomach contents consisted of a great many house-rats (*R. r. alexandrinus*), and the remains of a skink (*L. ferrandi*). My captive serval showed a marked preference for chicken meat, though it would take vegetables at times. The stomach of another wild serval held nothing but grass, possibly seized after it had been trapped, as it was gin-trapped. Another was killed entering a gun-trap baited with a live goat; yet another was transfixed by a native's spear as it was eating the native's fowl—it was in very lean condition, which may account for it hunting fowls in daylight at 5 p.m.

I encountered a serval at Chanzuru at mid-day on one occasion, the sun being at full strength at the time. The animal was in the road, which was hedged in by aloes so that it could not easily escape, and I chased it for some way on my cycle. Serval were several times disturbed in long grass country, but they are very active and get away almost before one has time to shoot.

Twenty fleas (*Ctenocephalus felis*) were taken from one specimen, which was also afflicted with ticks (*Hæmaphysalis leachi*).

Felis ocreata ugandæ Schwann.

Kilenga in Kikami, Kimburu in Kisagara, Mvugi in Chigogo, Titu in Kinyaturu and Kiramba; Paka wa pori in Kiswahili.

Ten specimens from Ilonga, Kondoa, Tindiga, Kilosa, Dodoma, Mdjengo's, and Mtali's.

The largest male measured 583. 285. 133. 61 mm., and female 530. 308. 120. 60 mm. Tail-lengths seem to vary considerably and not in even ratio with the body-length.

In the sandy thorn-bush country (Dodoma to Mtali's) the Cats were of a very pale type, and I was inclined to think, after comparing the four skins with the six from Kilosa district, that they indicated a pale type. Just before I left East Africa, however, Capt. Godman shot a very pale example at Kilosa, almost in the spot where I had obtained some of the dark ones: it was quite indistinguishable from the thorn-bush type.

The dark wild cats are typical wild tabbies, and undoubtedly interbreed with domestic cats at times. At Kondoa I was shown a litter of six blind kittens under a pile of logs on the outskirts of an estate. Two of the kittens were all black, and four tawny-tabby. The house cat of the owner of the plantation was a black tom. I was called upon to shoot a brother of this black tom at Kilosa, which had been out fighting one night, and came home with the brain exposed and very much scratched; presumably he had had a dispute with a wild cat as there were no tame ones anywhere near.

Most of these cats were trapped whilst attempting to get at fowls. The stomach contents were:—(i.) fowl and grass; (ii.) lot of grass; (iii.) bodies of skinned birds; (iv.) two rats and a bird's feather; (v.) a rat (*R. r. alexandrinus*) and the remains of a fowl.

There were screw-worms on intestines and in viscera of one Tindiga specimen, but these were not preserved.

LYNX CARACAL NUBICUS (Fischer).

Simba wagi in Kikami; Simba mweng'we in Chigogo.

The East African Lynx is generally referred to the above race, so I have ventured to put down the subspecies, though no specimen was obtained. I saw one skin from Itumba in Manyoni sub-district in the possession of a friend, and the only one seen besides was one offered for sale at Shanwa, which had presumably been killed in the Mwanza District. The natives state that these animals hunt in parties of five or six but that they are rarely seen.

UNGULATA.

BOVIDÆ.

? BOS CAFFER RADCLIFFEI Thos.

Two specimens, a male from Myombo and female from Uluguru Mts. Very common at Kilosa and throughout the district, they frequently enter the Otto Plantation and have been seen within a few hundred yards of the houses.

My native collector, Salimu, shot the cow with a 12-bore gun in circumstances of sufficient interest to justify my repeating them here. Buffaloes had been doing damage in a shamba on the mountain-side, and the owner of the plot spent several nights guarding his crops. He was only armed with a spear, and on one night was chased by a young cow (he may have attacked the animal first), the native clambered on to a rock, and the angry animal fumed at the base of it attempting to reach him: he leaned over and stabbed it with the spear about six times along the spine, the spear barely penetrated below the skin. The animal did not leave the shamba with the rest of the herd next morning but lay up in the mtama near a path. It charged two natives, throwing them down and sticking its horn into the side of one, but the horns being short not much damage was done.

Knowing nothing of this, Salimu was returning from collecting birds the following morning when Jumbe Magoma (the local headman) came running towards him along the path and unceremoniously clambered into a tree. Salimu called out to know what was the matter, and hardly had received the reply 'Buffalo' gasped out by the somewhat winded jumbe, when round a bend in the path came the infuriated buffalo. Salimu states that he jumped up on a rock some eighteen inches high close to the path, and as the animal came for him he fired the only charge of S.S.G. which he had full in its face. The animal stopped and shook the blood from its face, and profiting by this interval Salimu essayed to clamber into the jumbe's tree, but before he had made good his seat the buffalo butted the tree and nearly succeeded in dislodging him. As soon as he was firmly seated he took the gun from the jumbe and loaded it with No. 3 shot, which he fired in the animal's face every time it came back. In all he fired at it six times before it drew off, swayed, and finally fell.

An examination of the skull shows that the S.S.G. smashed a large hole in the frontal bone; the shot was very close, so that the animal must have been nearly on to him when he fired. The skull was pitted with No. 3 shot in every direction, most of which did not penetrate, but I imagine some entered by the hole already made by the S.S.G., and the animal mainly succumbed to loss of blood from the first charge.

Bubalis cokei wembaerensis Zuk.

A single male (1860. 370. 520. 200 mm.) from the Wembere Plains near Dombolo, 9. xi. 21. I use the above, possibly invalid, subspecific name as this Hartebeest is from the type-locality of this alleged race.

Bubalis lichtensteini Peters.

A male (1900. 432. 513. 210 mm.) and a female were shot at Kipera on 8. ix. 22. The latter held a female fœtus (630. 220. 260. 90 mm.), and I collected twenty maggots of a bot-fly (non det.) from the nostrils of the adult. The species is quite common at Kipera, the largest herd numbered perhaps twenty, but they usually go in parties of five or six. When a suitable thicket is found in which to rest, they return to the same spot day after day.

Damaliscus korrigum jimela Matsch.

A male (2230. 370. 435. 190 mm.) and female (1890. 360. 435. 190 mm.) Topi were shot at Sagayo on 3. xi. 22. This must be very near the type-locality of the subspecies. There were two other adult females with calves running to heel with this bull; the female shot was the smallest of the three. In its stomach were grub-like parasites.

Connochætes taurinus taurinus Lyd.

Nyumbu in Kikami, Kisagara, and Kiswahili.

A single male Wildebeest (2380. 530. 480. 225 mm.) on the Mkata Plains, 13. ix. 21. It was accompanied by four females.

Cephalophus melanorheus schusteri Matsch.

Sesi in Kikami.

A pair of Blue Mountain Duiker (♂. 610. 190. 88. 50 mm. ♀. 670. 180. 60. 55 mm.) were killed by natives in their gardens at Bagilo, Uluguru Mts.

Cephalophus grimmi shirensis Wrought.

Funo in Kikami, Kisagara, and Kiswahili.

A single pair of Duiker were shot on the hills behind Kilosa during December 1920 (♂. 825. 100. 225. 100 mm.). They are quite common, but owing to the long grass and the quickness of their hearing, very difficult to procure.

A fly (*Hippobosca capensis* v. Olf.) was taken on one of these Duikers.

Oreotragus oreotragus schillingsi O. Neum.

Ngulungulu in Kisukuma and Kiramba. The Kiswahili name for all Klipspringers, viz. Mbusi mawe—the goat of the rocks—is in general use however.

Schillings' Klipspringer was met with at Mtali's and Sagayo, a pair being obtained (♂. 630. 35. 190. 80 mm.). When feeding among the bushes at the foot of their kopjes in the early morning they appear boulder-grey, and may easily be mistaken for Duikers if not expected.

Ourebia cottoni Thos.

A single male of Cotton's Oribi (770. 70. 200. 150 mm.) was shot at Sagayo on 6. xi. 22 in grassy maiombo and thorn-bush country.

Raphiceros campestris neumanni Matsch.

The subspecific name is given on geographical grounds, for my specimens combine key characters of several races of *R. campestris* as given on page 149 of vol. ii. of the 'Catalogue of Ungulates.' They have (i.) a dark coronal mark, (ii.) a dark brown, triangular nasal spot, (iii.) a white ring round the eye and much white on the oral margin, lips, chin, throat, and inner surface of the limbs. Having compared them with skins in the British Museum, it seems very doubtful if some of these races are sound.

Three specimens of Steinbuck from Shanwa and Sagayo, viz. male adult (909. 50. 209. 105 mm.), female adult (855. 49. 205. 105 mm.), and female immature (540. 40. 190. 91 mm.). The latter was kept in captivity for three months and made a charming pet. It was only given milk, and grazed about for itself in the vicinity of the camp. When it wanted milk it used to attack the backs of the native's knees with vigorous pushes accompanied by loud sucking noises, and would give no peace till attended to. Its death was solely due to the stupidity of a porter, who was carrying it and took no notice of the little creature strangling itself.

RHYNCHOTRAGUS KIRKI NYIKÆ Heller.

Kizimba in Kisagara, Chizimba in Chigogo, Sala in Kisukuma. Paa for all Dikdik in Kiswahili.

Eight males and six females were shot at Mbala, Igulwe, Pooma, Mtali's, Usurwe, Usshora, Ulugu, Mkalama, and Sagayo. The largest male measured 725. 41. 200. 80 mm., and largest female 700. 50. 210. 80 mm. They show a good deal of variation, particularly as to the presence or absence of white spots upon the legs.

At Igulwe a female was shot on 7. ii. 23 which held a small ♀ fœtus, measuring 85. 4. 22. 6 mm. The Usshora specimen was caught by a dog, and I imagine may only have been dropped that day (30. x. 21). It lapped milk readily, but died on the night of the second day though excreting normally. At Mbala on 27. ii. 23, an immature male, whose horns were just sprouting (♂. 580. 33. 175. 70 mm.), was running with its mother (♀. 690. 50. 195. 75 mm.); who appeared to be still nursing him.

These little buck are quite common throughout the Dodoma thorn-bush country, often in places where there is not a drop of water and the vegetation apparently dried up. They have a habit of resorting to the same spot to relieve themselves, as a civet does also. At Singida I came upon a place where both these animals had been using the same spot for several days at least.

The Pooma specimen was heavily infested with fleas, which have been identified as *Ctenocephalus felis* and *isidis*.

REDUNCA REDUNCA TOHI Heller.

Tohi in Kikami and Kiswahili; Nhohe in Kisagara.

Though Reedbuck were comparatively common a few miles from Kilosa, I never shot one, and the only specimen obtained was the skull of a male shot by Capt. Turnley on 28. xii. 20. Reedbuck were several times found which had been killed by leopards.

KOBUS ELLIPSIPRYMNUS Osg.

Kuru in Kikami and Kiswahili; Nhulu in Kisagara.

A male Waterbuck (2110. 390. 490. 210 mm.) at Kipera on 26. viii. 22, and a female (1750. 340. 470. 200 mm.) from Mkata River on 1. ix. 21. The latter had a very minute fœtus. One was found that had been killed by lions near the Simbiti River.

ÆPYCEROS MELAMPUS SUARA Matsch.

Palla in Kinyaturu and Kiswahili; Mpalla in Kiramba.

A male Impalla from Zengaragusu on 2. x. 21, a female (1040.

138. 142. 130 mm.) from Mbulu's held a large fœtus on 14. x. 21, whilst another female shot at Sagayo on 31. x. 22 held a very minute one. Large herds were met with on the Mkata Plains during the dry season. Two instances of Impalla being pulled down by leopards on the Wembere Flats during the dry season came under my notice.

Gazella thomsoni Günther.

Lala in Kisukuma and Kiswahili.

A single male Thomson's Gazelle (1165. 245. 350. 130 mm.) from Sanga, and six females from Nduguyu River, Sanga, and Mwadira, of which the largest measured 1160. 200. 350. 120 mm. Of the two females from Mwadira, one had a back-turned horn nearly growing into the skull between the ears, whilst the other had a horn missing. This latter held a fœtus (19. x. 22), as did one of the Sanga specimens shot on 16. x. 22.

Hippotragus equinus langheldi Matsch.

Kolongo in Kinyamwezi, Kisukuma, and Kiramba. Korongo in Kiswahili, obviously a borrowed and corrupted name.

Roan were met with at Izikisia near Tabora (Tabora being type-locality of the subspecies), Mlewa's in Mkalama, and Sagayo. A pair were shot in the last-named locality, where the species is quite common; herds numbered from five to thirty individuals, one or two herds being met with daily. The male measured 2240. 480. 600. 290 mm., and the female 2280. 430. 480. 282 mm.; the latter held a foal nearly ready to drop (♂. imm. 760. 180. 330. 138 mm.), which was somewhat of a surprise as the males were running with the does.

In the stomach of the female were tapeworms (*Stilesia hepatica* Wolffhugel) and nematodes (*Setaria labiato-papillosa* Aless.), whilst microfilaria of the unsheathed variety appeared in blood-films.

Hippotragus niger roosevelti Heller.

A single female (measuring 1900. 350. 350. 210 mm.) was shot on the hills behind Kilosa on 20. xii. 20. There were some thirty animals in the herd. A larger herd was met with at Mkata, whilst single individuals were of common occurrence at Kipera. Tabanids were present in large numbers on the animal that was shot, but no tsetse.

Tragelaphus scriptus massaicus Neum.

Mbala in Kikami and Kisagara.

Bushbuck are very numerous at Kilosa, but only a pair were shot, the male with a shot-gun from the verandah of the house. A female was shot on the banks of the Simiyu River on 31. x. 22, which has been referred to this race though the two skins are very different.

Measurements of Kilosa ♀ 1170. 180. 340. 130 mm., and Sagayo ♀ 1180. 150. 335. 140 mm. In the latter was a fœtal female, 480. 68. 180. 76 mm.

A male was found dead in fine condition, and I attribute its death to the bite of a puff-adder, there being a puncture on the haunch, the blood was fluid and much hæmorrhage about the vent (Kilosa, 26. iii. 21). Another was found in a donga that had been killed by a leopard, which had sprung on its back and had been carried some yards by the buck—a very old male. Setting gins for leopards on paths frequented by leopards is not altogether satisfactory, as I know of two instances in which bushbuck stepped into the traps and were caught; in one of these cases the leopard added insult to injury by carrying off the buck.

Suidæ.

Choiropotamus choiropotamus dæmonis Major.

Nguruwe in Kikami and Kiswahili; Ngubi in Kisagara.

A young male (730. 305. 235. 120 mm.) Bush-pig was shot by my collector in rank grass into which the native had forced his way to pick up a monkey. A large pig which accompanied it (? mother) attempted to urge it away by rending its belly with her tusks, and inflicted no fewer than twenty-three large cuts as she endeavoured to push it along (Tindiga, 28. i. 22).

Mrs. Billinge, of Iringa, wrote me that the wild pigs of Rumruli appear to be a smaller race, very fierce, and that "they play havoc with dogs." She sent in a half-grown one which, being confined in a room, sprang up around the walls to a height of two feet clear of the ground and eventually killed itself (♂. 800. 240. 180. 120 mm.). Three other captive young ones died as a result of being exposed to the sun, and one of these which I measured was ♂. 400. 135. 110. 65 mm. (Kilosa, 1. ii. 22).

Phacochœrus æthiopicus massaicus Lönnb.

Ngiri in Kikami, Kisagara, Kisukuma, and Kiswahili.

Four Warthogs were shot at Sagayo, of which the largest male measured 1110. 360. 210. 120 mm. and was plumbeous in colour. A female (1220. 350. 195. 119 mm.) shot the same day was brickish red. A few days before (2. xi. 22) a plumbeous female was seen accompanied by three bright rufous young ones.

On the Mkata Plains one day I stood face to face with a Warthog at about a hundred yards distance and mistook it for the gnarled roots of an overthrown tree; a second Warthog standing immediately behind the first, but with its head down, helped to foster the illusion of a fallen tree-trunk.

The Sagayo specimens were swarming with tsetse (*Glossina* *swynnertoni* Austen), and had many worms (*Ascaris lumbricoides* L., young ♀; *Œsophagostomum* sp. n.) in their stomachs, but blood-smears taken from them gave negative results.

EQUIDÆ.

EQUUS QUAGGA CRAWSHAYI de Wint.

Punda milia in Kiswahili, Sangeri in Kizungwa, Nhyenie in Chigogo, Nguo in Kiramba and Kisukuma.

Three specimens were shot at Mtali's, Simbiti River, and Sagayo respectively. The Mtali specimen was a very old male (2470. 470. 525. 190 mm.), the Sagayo female measured 2400. 430. 520. 170 mm., and was carrying a foal very near birth (♀. 1030. 220. 390. 105 mm.) on 2. xi. 22.

There were maggots in her stomach, a large tapeworm (*Anoplocephala rhodesiensis* York. & South.) nearly an inch wide, and nematodes (*Setaria equina* (Abildg.), ♀). The Mtali male had worms (*Crossocephalus viviparus* (Linst.) ♀ and *Strongylus vulgaris* Less. ♀ ♀, and *S. asini* Blgr. ♂ ♂), with numerous Œstrid larvæ in its nostrils, and scores of ticks (*Amblyomma* sp., *Hyalloma ægyptium* var., and *Rhipicephalus evertsi* Nn.) about the anus.

ELEPHANTIDÆ.

ELEPHAS AFRICANUS KNOCKENHAUERI Matsch.

Ndoo in Kinyaturu.

A fact worth recording was the appearance of four Elephants some 200 yards from the Boma at Singida at daybreak on 6. x. 22. The country is for the most part open rolling downs with occasional rocky kopjes here and there. It was surmised that the animals wandered from the western side of the lake west of the Boma, where Elephant are known to exist in the dense but low thorn-bush scrub. They drank at the lake east of the Boma and lost their way. They were fired on by the native police at the Boma, and the male was wounded, he was followed up and killed in a native garden some five miles north. He measured ten feet at the shoulder, and his tusks weighed about 40 lbs. apiece. One ear had a curious long tail about 8 inches in length, doubtless caused by some injury. The other ear, which I preserved and which is now in the Game Dept. Office, had two holes in it as if made by bullets at some time or other. Presumably I am correct in referring it to this race.

PROCAVIIDÆ.

PROCAVIA BRUCEI PRITTWITZI Brauer.

Mhimbi in Chigogo, Pimbi in Kinyaturu. Pimbi is also the Kiswahili name for all species of Hyrax.

Eleven specimens from Gwao's, Mbulu's, Pooma, Singida (seen), Mdjengo's, Mtali's, and Tabora. Skins from Dodoma and Tabora referred to *P. frommi* in my last notes have since been referred to this race.

Largest male 450. 0. 64. 35 mm.; largest female 470. 0. 60. 32 mm. Pregnant female with two minute fœtuses at Gwao's on 10. x. 21. Another also with two fœtuses at Mdjengo's on 24. x. 21, and two very large fœtuses in a Tabora female on 18. xi. 21.

Like all the other hyraces their stomachs contained finely masticated, bright green leaves of the shrubs which grow about the bases of the rocky kopjes where these creatures dwell.

Fleas (*Xenopsylla isidis*) were very numerous on the Mbulu specimen.

PROCAVIA BRUCEI MATSCHIEI Neumann.

Twenty specimens from Shanwa and Sagayo, where they are very abundant on the rocks, and at the former place 'barked' loudly when approached.

The largest male measured 530. 0. 75. 30 mm., and female 545. 0. 67. 30 mm. Three of the Shanwa females held minute embryos on 20. x. 22. There were three in one and two in the others. The stomachs of those examined were clean.

I had a young male alive for a fortnight, which fed readily on green stuffs and allowed itself to be stroked, but was very nervous of shadows and of being suddenly approached. It succumbed to a severe hailstorm.

PROCAVIA TERRICOLA SCHUSTERI Brauer.

Mhelele in Kikami.

Six specimens from the Uluguru Mts. Largest male 605. 0. 77. 35 mm. The largest female does not exceed the measurements of the one recorded under *Procavia* sp. on p. 67 of my earlier paper. The youngest female taken this time measured 240. 0. 45. 20 mm.

36. Observations on the Development of the Sympathetic Nervous System and Suprarenal Bodies in the Sparrow.

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(Text-figures 1–20.)

Introductory.

In the course of an investigation suggested to us by Prof. J. P. Hill, as to the origin and development of the suprarenal bodies in the Sparrow, we have been led from a consideration of the source of the chromaffin cells in those bodies, to an examination of the development of the sympathetic nervous system. The origin of this system has been a much-debated question for many years, and the excellence of the material provided for us by Prof. Hill has tempted us to put forward an account of our observations on this subject, more particularly as concerns the relations of the so-called primary and secondary sympathetic cords.

While confirming on the whole the view maintained by the majority of modern embryologists as to the ectodermal origin of the sympathetic system, the investigation has brought to light certain interesting facts which do not appear to have been recorded by previous observers, while we venture to think that the confirmation of previously recorded observations may be of some value.

Our observations have been made on a series of nearly a hundred Sparrow embryos collected during the years 1919–21. Unfortunately little is known as to the exact age of these embryos, but by a careful comparison of the stages of development reached we have been able to arrange them in a series. Keibel's 'Normal Table of Chick Embryos' has been of considerable assistance in this task.

The embryos were fixed by various methods, the most successful being that of Gerhardt. Prof. Hill also placed at our disposal some chick embryos treated by Bielschowsky's method. The best staining results were obtained by the use of Heidenhain's iron hæmatoxylin.

* Communicated by Prof. D. M. S. Watson, F.R.S., F.Z.S.

As excellent historical reviews of this subject can be found in the papers of Kuntz (**11**), Goormaghtigh (**6**), and Da Costa (**3**), and in the 'Text-Book of Human Embryology' of Keibel and Mall, we do not attempt a further summary, but confine ourselves to a restatement of previous observations on the primary and secondary sympathetic chains in birds and in such other vertebrates as have been observed to possess them.

Wm. His, Jun. (**8**), was the first to describe the occurrence in chick embryos of primary and secondary sympathetic chains. He observed, in a 4-day chick, a sympathetic chain similar to that found in other vertebrates, *i. e.* situated immediately behind (*i. e.* dorsal to) the carotids and on each side of the dorsal aorta. At the 8th day, however, he found a second cord immediately in front of the anterior (ventral) roots of the spinal nerves. This second cord, he says, soon outgrows the former in size and is enclosed in the vertebrarterial canal. He was unable to trace the subsequent fate of the primary cord.

In a later paper (**9**) the same author again discusses the relations between the primary and secondary cords. He is of opinion that the primary cord in the neck region atrophies, whilst in the thoracic and abdominal regions it forms the aortic plexus and thence migrates along the mesentery to the organs situated in those regions. He regards the primary sympathetic of the trunk region as only a step on the path of the sympathetic cells from the spinal ganglia to the periphery, and lays considerable stress upon the resistance offered to the migratory nerve cells by the mesodermal elements.

The secondary sympathetic cords he describes as the latest formation of the spinal ganglia, and suggests that the formation of the former is due either to a loss of migratory power in the sympathetic cells or to an increased resistance offered by the mesoblast.

Miss W. Abel (**1**) adopts the views put forward by His, Jun., but has observed a small contribution from the primary to the secondary sympathetic cord, although she lays little stress on her important observation.

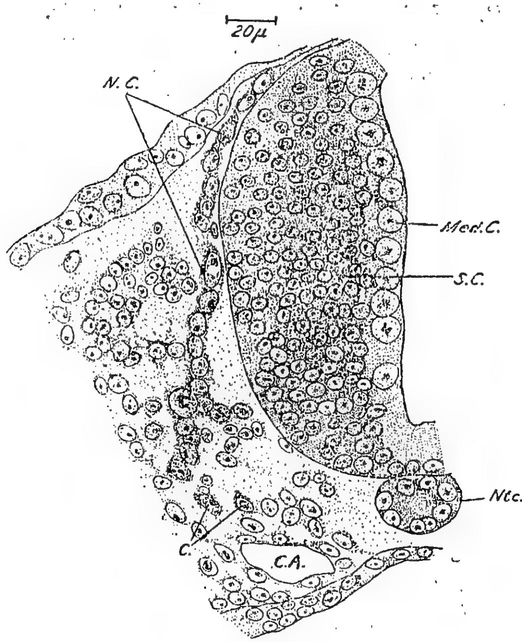
Kuntz (**11**) and Ganfini (**5**) support the main findings of His. They have also observed in Chelonia the existence of a secondary sympathetic. All these writers are agreed in describing the secondary sympathetic as a new formation quite independent from the primary sympathetic system.

A. *Relations of the Sympathetic Primordium to the Neural Crest.*

While Held (**7**) derives the sympathetic primordia exclusively from the dorsal root ganglia, and Kuntz (**12**) is of opinion that the chief part is derived by way of the ventral roots, our observations lead us to support the view put forward by Streeter (**12**). He writes: "As the neural crest becomes detached and its segmenting part invades the space between the myotomes and the neural tube, certain ganglion cells separate themselves from its ventral border and independently migrate ventralward into the neighbourhood of the aorta. It is these cells that form the connected chain of errant ganglia which we know as the sympathetic system."

Thus in Sparrow 16 of 6–7 somites [= 32-hr. chick] we find a well-marked neural crest, reaching from the dorsal border of the spinal cord nearly to its ventral edge. From the distal end

Text-figure 1.



Transverse section of Sparrow 16 (6–7 somites), showing spinal cord and developing neural crest. From the ventral end of latter cells (c) are proliferated towards the carotid artery.

C. Migrating cells. *C.A.* Carotid artery. *Med.C.* Ependymal cells. *N.C.* Neural crest. *Ntc.* Notochord. *S.C.* Spinal cord.

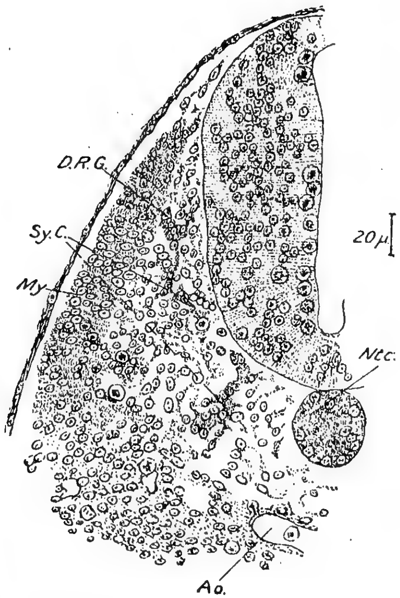
(Sp. 16, slide 3, row 3, section 12.)

of the crest, cells appear to be proliferated into the mesenchyme between spinal cord and aorta (text-fig. 1). The crest at first consists, in section, of a single row of cells with deeply staining cytoplasm and with large, oval, lightly staining nuclei. They have usually one large nucleolus, but two are sometimes present. The cells of the crest show mitotic figures especially at its ventral edge. Between the latter and the dorso-lateral angle of the aorta there are isolated cells with identically the same characteristics as those of the crest, and clearly distinguishable from the surrounding mesenchyme cells. The latter have much smaller and spherical nuclei and are distinctly branched, their processes being united so as to form a cell network. Their cytoplasm stains much lighter than that of the crest cells. The cells proliferated from the neural crest are not found in every section, but are most marked in the inter-somitic regions, where later we find the ganglia of the primary sympathetic cords.

B. *Relations with the Dorsal Root Ganglia.*

With the expansion of the neural crest to form the dorsal root ganglia the process of proliferation of sympathetic cells increases, and as is shown in text-fig. 2 from Sparrow 15 (= 42-hr. chick)

Text-figure 2.

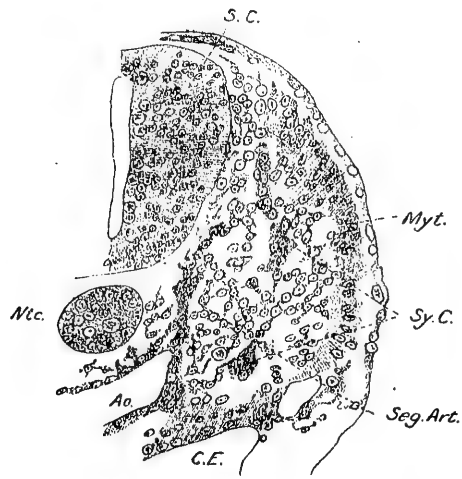


Transverse section of Sparrow embryo 15 (= 42-hr. chick), showing a succession of cells (*Sy.C.*) migrating to the dorso-lateral angle of the aorta.

Ao. Aorta. *Sy.C.* Sympathetic cells. *D.R.G.* Dorsal root ganglia. *My.* Myotome. *Ntc.* Notochord. (Sp. 15, 2, 4, 15.)

there is a succession of cells apparently migrating to the dorso-lateral angle of the aorta. These cells occur between the myotome, now considerably developed, and the spinal cord. The cells still possess large clear oval nuclei above described, but the surrounding cytoplasm appears to lose its individuality, with the resulting formation of syncytial masses or strands, in which there is evident mitotic activity. Kohn (12) figures such strands in the Rabbit. Streeter (12) considers this syncytial character to be only transitory, and associates it with the period of migration. Contemporaneously with this migratory activity of nervous elements the primordia of the segmental arteries and veins are being laid down. Thus in text-fig. 3 we see that the endothelium of the dorso-lateral angle of the aorta has proliferated to form a distinct strand of cells, which will ultimately develop into a

Text-figure 3.



Transverse section of Sparrow embryo 15 (= 42-hr. chick), showing development of segmental artery and migration of sympathetic cells (*Sy.C.*).

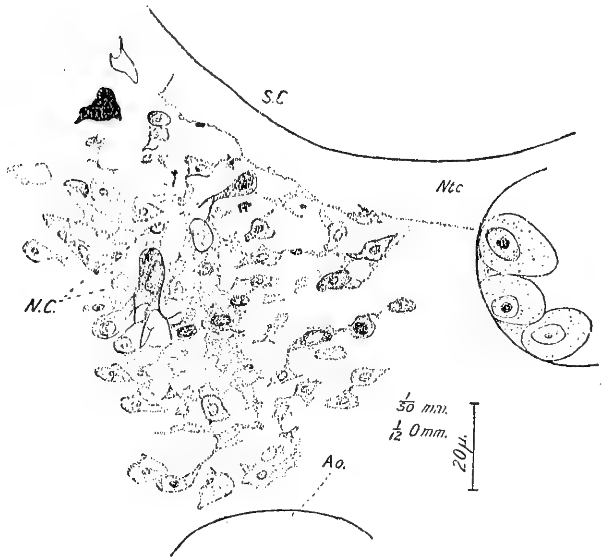
Ao. Aorta. *C.E.* Cœlomic epithelium. *Myt.* Myotome. *S.C.* Spinal cord. *Seg.Art.* Segmental artery. *Sy.C.* Migrating sympathetic cells. *Ntc.* Notochord. (Sp. 15, 3, 1, 1.)

segmental artery. Similar vascular strands may be seen in other sections arising from the cardinal veins. The nuclei of the cells in these vascular strands are very irregular in shape, and their cytoplasm is considerably lighter and less granular than that of the nerve strands. In view of the fact that some authors have been led to consider such strands as of nervous significance, we venture to direct special attention to this differentiation.

That the cells migrating from the dorsal ganglia are neuroblasts is confirmed by silver preparations of chick embryos in which the ventral roots have not yet appeared, *i.e.* of less than

60 hrs. Text-fig. 4 is drawn from a section of such an embryo. It shows neuroblasts isolated between spinal cord and aorta

Text-figure 4.



Transverse section of chick of $2\frac{1}{2}$ days (Bielschowsky preparation), showing amid the mesenchyme cells isolated neuroblasts (*N.C.*) between spinal cord (*S.C.*) and aorta (*Ao.*).

possessing distinct nervous processes. The neuroblast has a large oval nucleus, and its processes are directed towards the aorta.

C. *Relations with the Ventral Roots.*

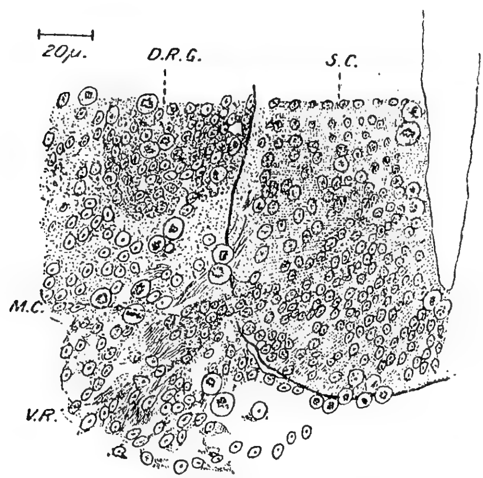
Whilst all investigators are not agreed as to the origin of sympathetic cells from the neural crest before its differentiation into the dorsal root ganglia, most are agreed that the ganglia when formed give origin to the sympathetic cells. Held (**7**) goes so far as to derive the whole of the sympathetic ganglia from the *dorsal* root ganglia. His evidence is based on the examination of Selachian material, but he is so satisfied with those observations that he applies his deductions to the case of chick embryos, although he confesses that he has not been able to discriminate the roots satisfactorily in them.

Kuntz (**11, 12**), on the other hand, attaches by far the greater importance to the ventral roots as the path by which the cells migrate, a view which he supports by both morphological and experimental evidence.

In collaboration with O. V. Batson he experimented on chick embryos. By electrolysis they destroyed the dorsal part of the neural tube of the embryos, and in four successful cases found that the sympathetic primordia were formed to a greater or less extent. Kuntz later carried out further work on the same lines and arrived at similar results. Of similar experiments carried out on tadpoles, by actual dissection, he writes: "As far as the study of the development of the sympathetic trunks was pursued in these embryos the findings corroborated those in the operated embryos of the chick."

The experimental investigations of E. Müller and Sven Ingvar (**13**), on the other hand, support the conclusions of His and Held.

Text-figure 5.



Transverse section of Sparrow embryo 11 (= chick about 78 hrs.), showing cells leaving the spinal cord by the ventral nerve root.

D.R.G. Dorsal root ganglion. *M.C.* Migrating cells. *S.C.* Spinal cord. *V.R.* Ventral root. (Sp. 11, 4, 2, 17.)

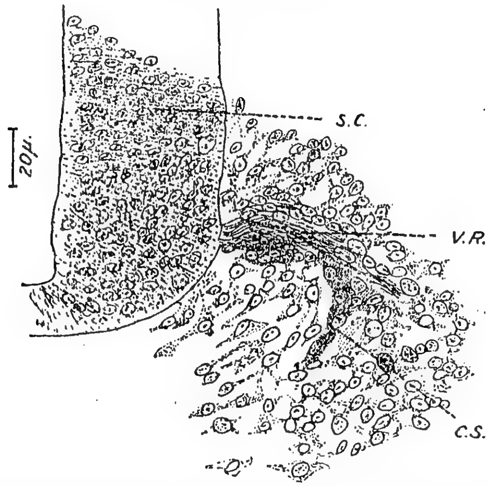
They carried out their experiments on Amphibian material. By destroying the ventral part of the neural tube they found that the sympathetic was still formed, while the removal of the dorsal portion resulted in its failure to develop. They thence conclude that the primordia of the sympathetic nervous system arise from the spinal ganglia.

The conflicting results obtained by these workers illustrate the pitfalls inherent in the experimental method as applied to this particular problem.

Our observations certainly do not support Held's view as to the exclusive origin of the sympathetic system from the dorsal root ganglia, but they lead us to attach somewhat more importance to that source of origin than Kuntz would seem to allow.

Text-fig. 5 shows the ventral root of a Sparrow embryo, No. 11 (= 78-hr. chick). The ventral roots are well developed, and the one figured shows a group of cells close to the origin of the root, and evidently in course of migration. That the migration is outwards seems clear from the observation of a later stage, such as is reproduced in text-fig. 6 of Sparrow 51 (= 84-hr. chick). Here we find some of these migrating cells leaving the ventral root and making their way to the dorso-lateral angle of the aorta, at which point they join the previously described

Text-figure 6.

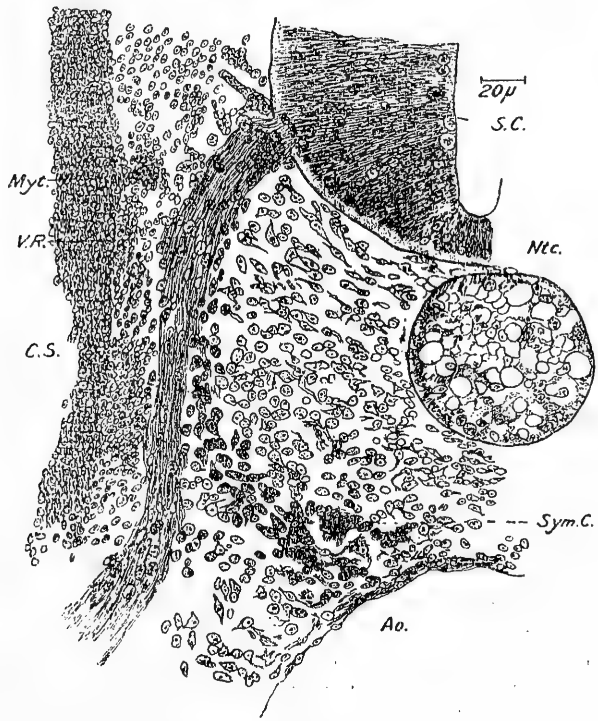


Transverse section of Sparrow 51 (= 84-hr. chick), showing cells leaving ventral root in the direction of the dorso-lateral angle of the aorta.
C.S. Cell strand. *S.C.* Spinal cord. *V.R.* Ventral root.
(Sp. 51, 3, 2, 4.)

sympathetic cells, and with them form diffuse masses of cells, which are the primordia of the primary sympathetic chains. At this stage the chains are not formed, but the diffuse cell masses occur metamerically at intervals corresponding with the somites.

This migration of cells along the ventral roots, and thence to the dorso-lateral angle of the aorta, is visible to a greater or less extent in all the embryos examined at about this stage (= 3–3½-day chick). Owing to the curvature of the embryo it is obvious that the occurrence of a transverse section passing along one of these migratory paths is quite fortuitous, though it can always be shown by reconstructions from consecutive sections, a method which Held employed for some of his illustrations. Text-fig. 7, however, shows a fortunate section of a chick embryo (D. 4 of $3\frac{1}{2}$ days), in which the curved track of darker cells is practically continuous, thus furnishing a striking picture of the path of migration. This path seems to be markedly affected by the

Text-figure 7.



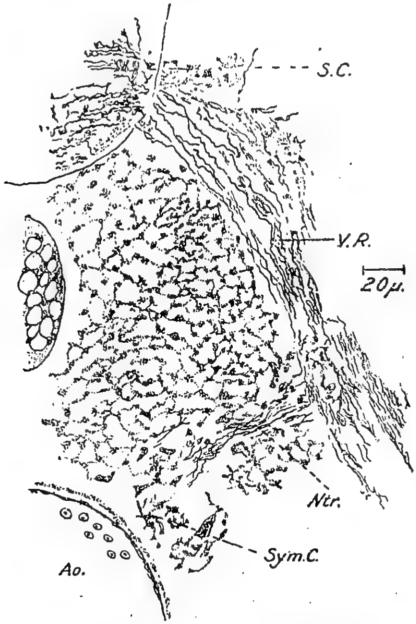
Transverse section of chick embryo ($3\frac{1}{2}$ days, D 4), showing an almost continuous strand of sympathetic nerve cells from the point of exit of the ventral nerve root to the dorso-lateral angle of aorta.

Ao. Aorta. *C.S.* Sympathetic cell strand. *Ntc.* Notochord. *Myt.* Myotome. *S.C.* Spinal cord. *Sym.C.* Group of sympathetic cells. *V.R.* Ventral root.

segmental arteries and veins, for it is between these vessels that the sympathetic cells move to their primary destination (see text-fig. 3). It is possible that the intersegmental region offers a path of least resistance to this migration.

A track of nerve fibres in the same position is clearly marked in silver preparations, such as that shown in text-fig. 8, and it seems probable that this path would agree with that of the migrating nerve cells.

Text-figure 8.



Transverse section of chick (*m*–4½) from a Bielschowsky preparation, showing nerve fibrils pursuing the same course as the sympathetic cell strand in fig. 7. The mesenchyme and other cells are much distorted, but some of those near the dorso-lateral angle of the aorta show evidence of being sympathetic in character.

Ao. Aorta. *S.C.* Spinal cord. *V.R.* Ventral root fibres. *Sym.C.* Sympathetic cells. *Ntc.* Notochord. *Ntr.* Nerve fibres in the track of migrating sympathetic cells.

While it appears that many of these cells are sympathetic in nature, the possibility must not be excluded that some of them will develop into the sheath cells of Schwann.

D. *The Primary Sympathetic Chain.*

In their earliest stage the primordia of the sympathetic chains consist of two parallel series of cell groups situated at the dorso-lateral angles of the aorta. These are arranged metamerically and show a more advanced stage of development in the anterior thoracic region. Ensuing stages show their gradual consolidation by the dispersed cells gathering into compact masses, and the simultaneous growth of longitudinal cellular strands, which unite them into continuous moniliform chains. Silver preparations show scattered fibres among these cells. A graphic reconstruction of the consolidated cord in the anterior thoracic region at this stage is shown in text-fig. 9 A.

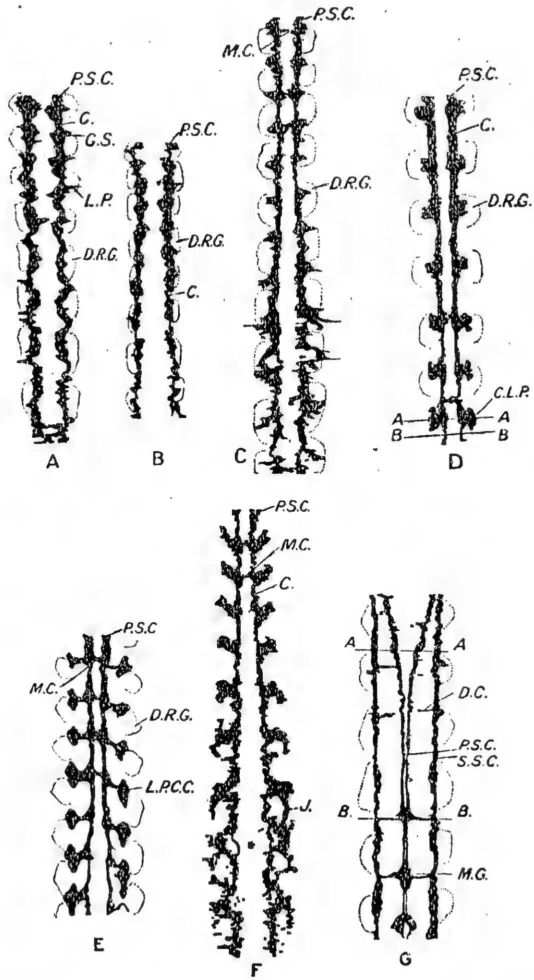
So far as we have been able to observe, the cells constituting the chain at this stage do not show any differentiation of chromaffin cells among them. Their nuclei are oval, their cytoplasm darkly stained and full of minute granules, cell boundaries are faint, or may still be absent. We have constantly observed the presence of clear spaces surrounding the groups of sympathetic cells near the dorso-lateral angle of the aorta. Kuntz has noticed these clear spaces. They may be spaces filled with lymph during life, or they may be due to shrinkage phenomena. We have followed the development of the cords by means of graphic reconstructions from a series of Sparrows, separated by very slight differences of development, and the result is striking. The series of reconstructions is shown in text-fig. 9.

We have chosen for purposes of reconstruction the anterior thoracic region of the embryo, where its development is most advanced. Text-figs. 9 A & B are reconstructions of the primary sympathetic nervous system of Sparrows 7 and 2 (= 78-hr. chick). They show that at this stage the sympathetic chains in the anterior thoracic region consist of two approximately parallel cords, formed by masses of cells united by their connecting strands. Anteriorly the strands are much thicker, but not sufficiently so to hide the metamerism, which corresponds exactly with that of the dorsal root ganglia. In both the text-figures, but more markedly in text-fig. 9 B, it will be seen that the swollen parts of the cord send out lateral processes. These processes do not run in the plane of the parallel cords, but are directed dorso-laterally. The apparent differences in the directions to which they point are due to the curvature of the embryo.

Text-fig. 9 C is from Sparrow 6 (= 84-hr. chick). The moniliform character of the strands is more marked and gives the impression that the swellings have increased at the expense of the connectives. The distances between the ganglionic swellings, *e. g.* in text-figs. 9 A & 9 C, are roughly equal, but the connectives in the latter have become more slender, a result which could be attained either by a process of degeneration, which seems improbable at this early stage, and of which no evidence was obtained in the sections, or by migration of their elements into the ganglionic swellings.

Similar migration seems to have taken place into the lateral processes, which are now connected by broad bases to the primary ganglia, and taper off to a point dorso-laterally to the cords. This certainly suggests that their growth is outward from these ganglia, a view supported by the frequent occurrence of mitoting

Text-figure 9.



Graphic reconstruction of the sympathetic primordia in the anterior thoracic region of Sparrows. The cord is viewed from the ventral surface and the metamerically arranged dorsal root ganglia are indicated by dotted lines. The lateral projections are not in the same plane as the cords, and allowance must be made for the necessary foreshortening in their projection.

A. Sparrow 7 (= 78-hr. chick). Cords continuous with slight swellings and short dorso-lateral processes.

B. Sparrow 2 (= 78-hr. chick). Cords continuous with slight swellings and short dorso-lateral processes.

C. Sparrow 6 (= 84-hr. chick). Swellings and processes much more pronounced.

Notice four mesial commissures and the proliferation at the posterior end which is the region where there exists a close relation between the sympathetic and the suprarenal bodies.

cells in both ganglia and processes. The posterior part of the chain in text-fig. 9 C still shows considerable dispersion of the sympathetic elements, and it is from this region that contributions are sent to the suprarenal bodies. In the anterior part the chains are united by transverse commissures.

Text-fig. 9 D represents a reconstruction of Sparrow 13 (= 96-hr. chick). The distinction between ganglia and connectives is much more marked, and an important change is also visible in the lateral processes. The four anterior pairs are still united by a broad base to the primary ganglia, but instead of tapering to a point they are now of practically the same thickness throughout. In the three posterior pairs the bases show signs of constriction, while the distal portion is marked by a cranio-caudal elongation. Now when we examine the cords themselves we find that they are thinnest just in the region where the lateral processes possess these cranio-caudal extensions, while in the anterior region, where the processes have not yet reached this stage, the cords remain of considerable thickness. We are again driven to the conclusion that the cranio-caudal extensions are formed at the expense of the primary cords.

Text-fig. 9 E, from Sparrow A (= 5½-day chick), shows a continuation of this development. The lateral processes are now solid masses, united to the primary chain by short connectives, and all of them show cranio-caudal extensions, the caudal being more marked. The correlation between the increased size of the lateral process and the thinness of the primary sympathetic chain is again very obvious.

The solid lateral masses are now situated in close relationship with the spinal nerves, being located just mesial to the junction of dorsal and ventral nerve roots. They may now be termed the primordia of the secondary sympathetic ganglia. Subsequent growth of their cranio-caudal extensions leads by their union to the formation of the definitive sympathetic chain (secondary sympathetic chain).

D. Reconstruction of Sparrow 13 (= 96-hr. chick). Ganglia and connectives more marked. Lateral processes thickened. Posterior ones constricted to some extent.

E. Reconstruction of Sparrow A (5½-day chick). Lateral processes now solid masses united to the primary chain by short connectives. All show cranio-caudal extensions.

F. Reconstruction of Sparrow 60 (= 6-day chick). Cranial-caudal extensions meet to form secondary sympathetic chain.

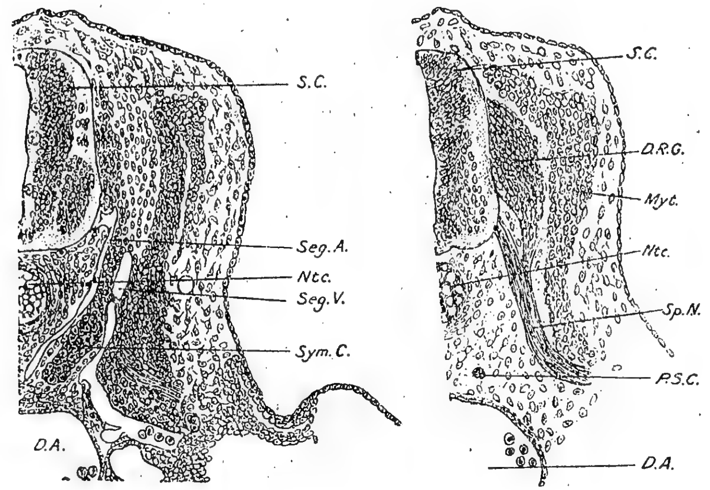
G. Reconstruction of Sparrow B (= older than Sparrow 60). Secondary sympathetic chain formed. Connectives between primary and secondary degenerating.

C. Connective. *D.R.G.* Position of dorsal root ganglion. *G.S.* Ganglionic swelling. *P.S.C.* Primary sympathetic cord. *M.C.* Median connective. *C.L.P.* Constricted lateral process. *L.P.C.C.* Lateral processes with cranio-caudal extensions. *J.* Junction of cranio-caudal extensions. *S.S.C.* Secondary sympathetic chain. *M.G.* Median ganglia. *D.C.* Degenerating connective.

E. *The Secondary Sympathetic Nerve Cords.*

An interesting example of this union is shown in text.-fig. 9 F, a reconstruction of Sparrow 60 (= about 6-day chick). We here see that at two points the secondary chain is actually completed, while in other places marked caudal prolongations are apparent. The completion of the formation of these definitive sympathetic chains is found at a stage corresponding to that of the seven-day

a. Text-figure 10 (*a* & *b*). *b.*



Diagrammatic figures showing relations of sympathetic cord to surrounding tissues as seen in transverse sections of Sparrow 13 at points marked A–A, B–B in fig. 9 D.

10 *a*. Passes through a ganglionic swelling of the sympathetic chain (*Sym.C.*). The ganglionic swelling lies dorso-lateral to the aorta (*D.A.*) and between the segmental artery (*Seg.A.*) and segmental vein (*Seg. V.*). There is a dorso-lateral projection pointing towards the position of the dorsal root ganglion.

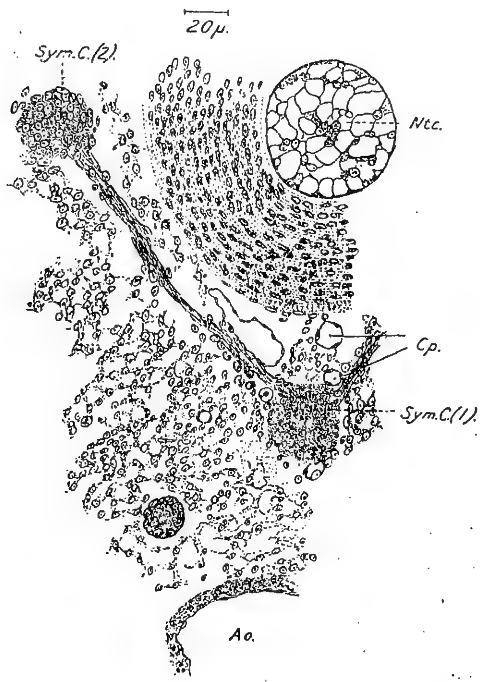
10 *b*. Passes through a connective (*P.S.C.*) between two ganglionic swellings. The two sections are only 56 μ apart.

D.A. Dorsal aorta. *D.R.G.* Dorsal root ganglion. *Myt.* Myotome. *Ntc.* Notochord. *Sp N.* Spinal nerve.

chick. A reconstruction of this stage is shown in text-fig. 9 G, Sparrow B.

The condition of the primary sympathetic chain at this stage presents very interesting features. The two cords are now much diminished in size and, gradually approaching one another, are for some distance almost in contact. Their moniliform character is lost, except that in the thoracic region we find three large median ganglia, partly or completely fused (text-fig. 11). These are joined to the secondary ganglia by connectives of nervous fibres. We have also found these median ganglia in a much more advanced embryo. The ganglia lie above the aorta immediately ventral to the vertebral column, the centra of which are in process of development. On either side of them there occur mesodermal masses, such as give rise to muscle in the adult, in

Text-figure 11.



Transverse section through Sparrow B at point marked A–A in fig. 9 G. The secondary sympathetic ganglion is shown at *Sym.C.* (2) and is connected with the median fused ganglia of the primary sympathetic (*Sym.C.*) (1) chain.

Ao. Aorta. *Cp.* Capillaries associated with primary sympathetic.

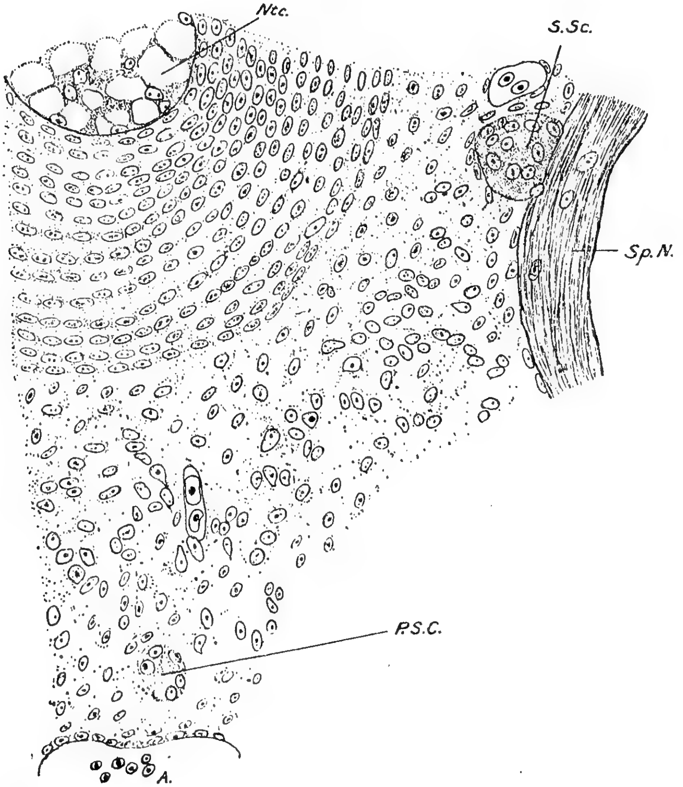
(Sp. B 9, 4, 7 and 8.)

this case probably to muscles attached to the vertebræ. The connectives between the ganglia are associated with a rich capillary plexus dorsal to the aorta.

Posterior to these ganglia the primary sympathetic cords diminish in size, until in the abdominal region it is no longer possible to trace them.

Transverse sections throw light on the processes of development above described. Text-figs. 10 *a* & 10 *b* show transverse sections of Sparrow 13 at the points marked A–A, B–B in text-fig. 9 D. The sections are only 56 μ apart, but the difference is very marked. The section shown in text-fig. 10 *a* passes through the dorso-lateral processes of the primary sympathetic chain, and shows their relations to the surrounding structures. They lie between the segmental artery and vein, and extend dorso-laterally from the aorta to a point about halfway towards the

Text-figure 12.



Transverse section through Sparrow B at point marked B–B in fig. 9 G. The secondary sympathetic chain (*S.Sc.*) is closely apposed to the spinal nerve.

origin of the ventral roots. The section in text-fig. 10 *b*, on the other hand, shows the primary sympathetic as a comparatively small strand close to the aorta. This section passes through the myotome and the dorsal root ganglion, while that shown in text-fig. 10 *a* passes between the somites.

Text-figs. 11 & 12 drawn from sections of Sparrow B, at points marked A–A and B–B in text-fig. 9 G call for some remark. Text-fig. 12 shows the primary and secondary sympathetic chains apparently quite disconnected. The primary has its usual position at the dorso-lateral angle of the aorta, the secondary is situated close against the spinal nerve, and lateral to the notochord. Text-fig. 11, however, shows a section through the connective between primary and secondary chains. The connective at this stage is composed chiefly of nerve fibres, but along them there are scattered cells, which are probably destined to form sheath cells. The two primary ganglia in this section will be seen to have completely fused.

F. *Rami Communicantes.*

The foregoing description of the development of the sympathetic nervous system will explain how there has arisen a considerable amount of confusion as to the *rami communicantes* in birds, for it will be seen that in this group there are no less than three distinct sets of connections associated with the central nervous system and the outlying sympathetic. These are:—

1. The strands of nerve cells which give rise to the primary sympathetic cords.
2. The constrictions of the dorso-lateral processes by which the primary cords are attached to the secondary ganglia.
3. The definite connections by which the secondary ganglia become attached to the spinal nerves.

Strictly speaking the term *ramus communicans* should be restricted to the last of these three groups, but previous papers and illustrations show that all these three forms have been thus designated. Ganfini (**5**) goes so far as to use the terms primary, secondary, and tertiary *rami communicantes* for the three classes of connections, but in view of their significance in neurology it would seem preferable to apply the name only to those fibres by which the definitive sympathetic is linked up with the mixed spinal nerve. As the definitive *ramus* does not arise till about the stage corresponding to that of a seven-day chick, it is evident that any connection between the sympathetic and the central nervous system, existing in earlier stages, must be looked upon as an example of either the first, or the second, of the types of connections above mentioned. As the history of their development shows, the connections of groups 1 and 2 have only a transient existence, with the possible exception of the connections in certain plexuses.

The three types of connections are characterized more or less definitely by their morphology. Those of the first group are formed of discontinuous cells, though silver preparations show that scattered nerve fibres occur in them. Connections of the second type, on the other hand, are formed by compact masses of cells, especially at their first appearance. In the course of their development they become elongated and may be narrowed down almost to a single row of cells. In their final stages their cellular character disappears by migration of the cells to the secondary chain, and a fibrous connection is left (text-fig. 11). With the exception of certain connections which are maintained with the chief plexuses of the trunk, these also ultimately disappear, usually after the appearance of the definitive *rami*. These last are from the beginning purely fibrous. Their development consists merely of a growth in length, as the secondary sympathetic ganglion moves away from its early position at the point of union of dorsal and ventral roots. The range of movement varies in different regions, being very small in the neck. Thébault (**14**) figures the *rami communicantes* of *Corvus* as sometimes quite distinct in the neck region, but also describes a fusion of the sympathetic ganglion with the spinal nerve, and remarks that all the intermediate stages may be found. A *ramus communicans* can always be found in our material by microscopic examination.

That the sympathetic ganglion, while making its own contribution to the mixed spinal nerves, carries with it fibres from both roots, has been abundantly proved by previous observers. Rossi (**16**), in his recent paper on the afferent paths of the sympathetic system, demonstrates by direct anatomical observations, that cells occur in the dorsal root ganglia which send their processes into the *rami communicantes*. These he regards as the cells of origin of Kölliker's fibres, and considers them to be afferent sensory neurones.

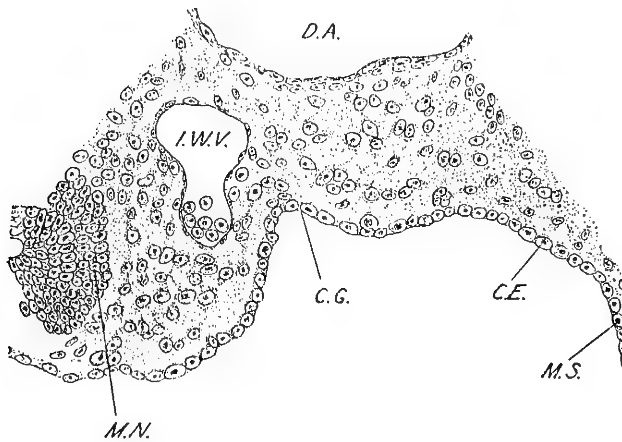
G. *The Suprarenal Bodies.*

Our observations lead us to agree with those who ascribe to these bodies a dual origin: *e. g.* Balfour, Poll, Mitsukuri, Giacomini, and Goormaghtigh.

In Sparrow 7 (= 78-hr. chick), text-fig. 13, there are already signs of the grooves in the cœlomic epithelium from which the cortical portion of the suprarenal bodies will arise. These grooves are situated on either side of the mesentery and close to it. Laterally to them will be found the internal Wolffian vein and the mesonephros, and in certain cases the external glomerulus of the pronephros can also be seen. In text-fig. 14 these relations are clearly visible, and the proliferation of cells has already started at the region described. The cells of the cœlomic epithelium are cubical with large nuclei. Mitotic figures are numerous and the products of division appear to be moving inwards. In Sparrow 8, text-fig. 15, the proliferation of cells becomes more marked, and a ridge is formed internally. These cortical primordia appear to be metamerically arranged. In Sparrow 11, text-fig. 16, the cortical primordia are very clearly marked, but still closely attached by a broad base to the cœlomic epithelium. Groups of cells appear to be moving towards their later position between the aorta and the mesonephros.

Sparrow 5, text-fig. 17, shows the separation completed; the primordia are now compact and contain a few cells from the primary sympathetic chain, which have migrated down the sides

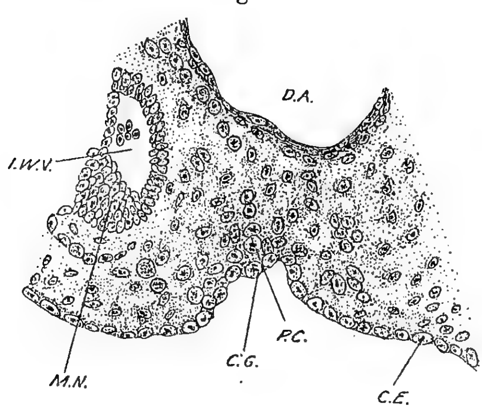
Text-figure 13.



Transverse section through Sparrow 7 (= 78-hr. chick), showing the formation of the cœlomic groove (*C.G.*).

C.E. Cœlomic epithelium. *D.A.* Dorsal aorta. *M.N.* Mesonephros. *M.S.* Mesentery. *I.W.V.* Internal Wolffian vein. (Sp. 7, 5, 3, 3.)

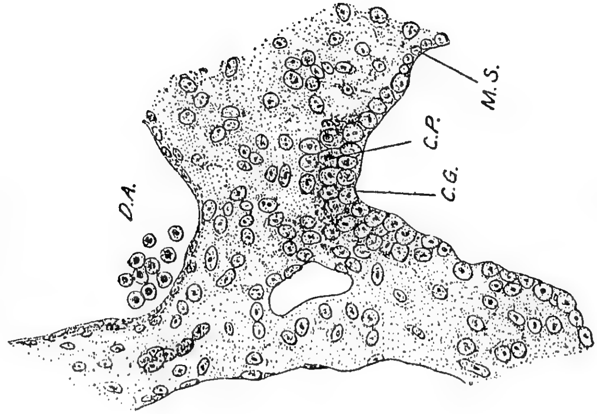
Text-figure 14.



Transverse section of Sparrow 8, showing the deepening of the groove (*C.G.*) and proliferation of cells (*P.C.*) to form the primordium of the suprarenal cortex. Letters as in fig. 13.

of the aorta. It is this contribution from the sympathetic chain which eventually forms the medullary tissue of the suprarenal body.

Text-figure 15.



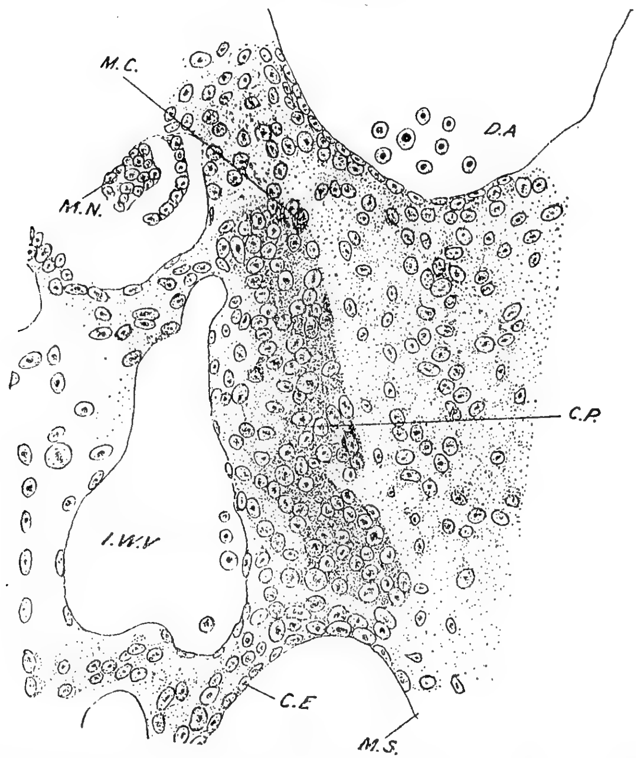
Transverse section of Sparrow 8, showing grouping of cells to form the primordium of the suprarenal cortex (C.P.). Letters as in fig. 13.

Text-figure 16.

Transverse section of Sparrow 11, showing a further development of the cortex. The suprarenal is now invading the internal Wolffian vein. Letters as in fig. 13.

Text-figs. 18 & 19, from Sparrow 53, show the relations of the sympathetic and the suprarenal body. The latter now surrounds the internal Wolffian vein, while the sympathetic chains dorso-lateral to the aorta are largely developed, and give rise to masses of cells which pass from them to the cortical primordia. The point of entry of these cells seems usually to be on the mesial face of the suprarenal body (text-fig. 18), but in text-fig. 19 there is apparently a dorsal entry.

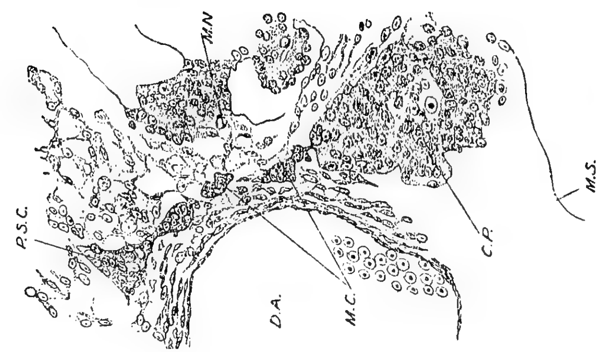
Text-figure 17.

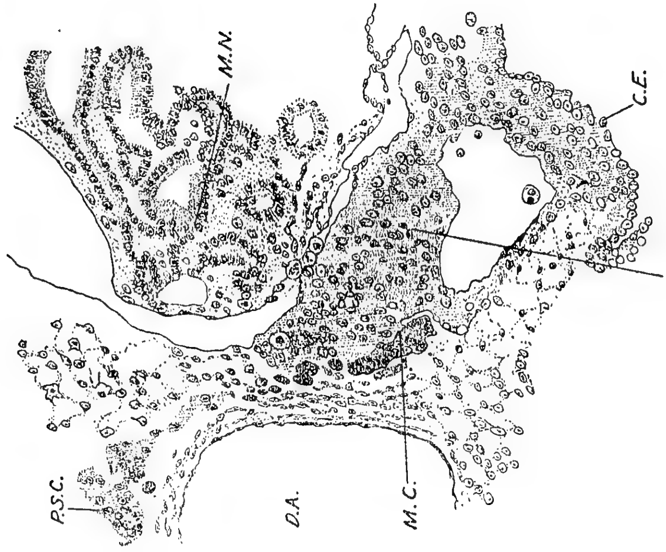


Transverse section of Sparrow 5, showing first signs of invasion of cortex by medullary cells (*M.C.*) from the primary sympathetic. Lettering as in text-fig. 13.

It is noteworthy that these contributions of the sympathetic to the suprarenal all arise from the primary sympathetic cords, which apparently proliferate them at about the same time as they are giving rise to the definitive cords, by the outgrowth of dorso-lateral branches, as described above. We have not attempted a detailed description of the changes which occur in the development of the suprarenal bodies, as these have been

Text-figures 18 & 19.





Transverse sections of Sparrow 53, showing contributions of primary sympathetic to suprarenal body. In fig. 18 the contribution is dorsal while in fig. 19 it is mesial.

(Sp. 53, 4, 4, 3. Sp. 53, 4, 5, 4.)

admirably set forth by Goormaghtigh in his recent paper. The only point on which our observations lead us to differ from him is as to the origin of the medullary substance. This is derived, according to our observations, from the primary sympathetic cords and not, as Goormaghtigh maintains, from the mesodermal cells of the sclerotome.

H. *Discussion.*

Since Francis Balfour (2) in 1877 described the development of the sympathetic nervous system in the Selachii, many theories have been put forward supporting, or refuting, his statement as to its origin. Without going deeply into the history of the controversy, we may summarize the chief suggestions as follows:—

A. *Origin ectodermal.*
 a. From the medullary tube.
 b. From the spinal nerve roots.
 c. From the dorsal root ganglia only.
 d. From ventral roots chiefly.

B. *Origin mesodermal.*
 Differentiation *in situ.*

C. *Mixed origin.*
 From the medullary tube and sclerotome.

Supporters of the mesodermal origin of the sympathetic nervous system have based their conclusions chiefly on the presence of the sympathetic primordia, at the dorso-lateral angles of the aorta and the carotids, *before* the appearance of the nerve roots. Although we agree with them in this observation, we are yet of the opinion that the cells in question have not differentiated *in situ*, but that they have been proliferated from the neural crest (see text-fig. 1).

We have not found a trace of support for the interpretation recently put forward by Dart and Shellshear (4), who state that "a mesodermal origin of these neuroblasts (*i. e.* neuroblasts in relationship with mesodermal structures) must therefore be postulated and is demonstrable." All nerve fibres which we have observed could either be traced from the central nervous system, or, in certain cases, from free cells closely associated with it, and in no case occupying a position such as would support their view.

With regard to Goormaghtigh's (6) contention for a mixed origin, we may state that we have kept a careful look out for the strands, which he describes as arising from the sclerotome and contributing to the formation of the primary sympathetic system, and have been entirely unsuccessful in our search. The paths of the migrating cells destined to form the sympathetic primordia certainly pass close to the sclerotomes, but the boundary between the two structures in our material has always been clearly marked, and the cells on either side of that boundary sufficiently differentiated to distinguish them. It is unfortunate that the photographic illustrations, which Goormaghtigh puts forward in support of his view, are far too indistinct to serve as evidence for it.

We are thus led to support the entirely ectodermal origin of the sympathetic nervous system, and from the observations already given, it will be seen that we do not confine that origin to any one part of the central nervous system. The statement by experimental physiologists that the sympathetic contains both afferent and efferent components, while it does not afford a proof of a diverse origin, yet supports the possibility of such being the case. We have seen that some cells originate very early from the neural crest, and we are convinced that both dorsal and ventral roots contribute towards the formation of the sympathetic primordia.

The observations of His (8) and Held (7) support the origin from the dorsal root ganglia. These writers describe the primordia as arising by cells, migrating from the spinal ganglia by way of the spinal nerve, from which they diverge a little beyond the point of their junction, and thence make their way to the dorso-lateral angle of the aorta. The sympathetic cells thus leave the spinal nerves at a point subsequent to the union of dorsal and ventral roots, and so may originate from either of those sources. The assumption that all have arisen from the dorsal root ganglion is based simply on an analogy with Selachian material, and has no foundation on observations of avian embryos.

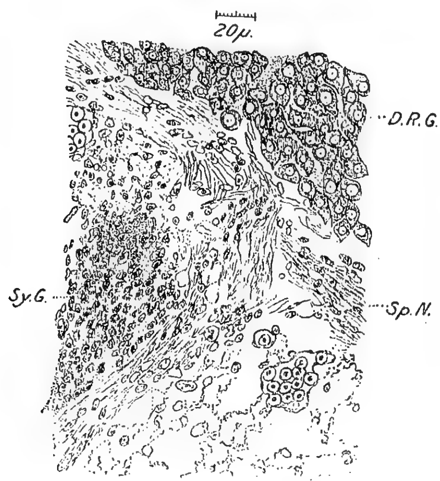
The descriptions of Held and His lead one to the supposition that this process is continuous throughout the development of the sympathetic; this, however, is quite contrary to the results of our investigations. If the sympathetic ganglia were derived directly from the spinal nerve, one would naturally expect the cells composing them to bear a distinct resemblance to those from which they are said to originate; but this we do not find to be the case. The cytological characters of the dorsal root ganglia, and of the cells of the ventral horn of grey matter, are so different from those of both primary and secondary sympathetic ganglia, that there seems no possibility of one being derived immediately from the other (see text-fig. 20).

Our description, as given in § E, of the morphological development of the sympathetic, allows ample opportunity for this differentiation to arise; for we discover that though the ganglia of the dorsal roots and the definitive sympathetic ganglia lie close to one another, yet the latter have had opportunity to undergo considerable changes in the course of their extensive migration, *first*, from the neural crest, &c., to the aorta, and, *secondly*, from the aorta to near the spinal ganglion.

The reasons for this complicated migratory movement have yet to be discovered, but the evidence for it is, we think, sufficiently definite. The situation of the definitive sympathetic in the vertebral canal in birds was pointed out as long ago as

1810 by Tiedemann, but the occurrence of a primary chain in a position analogous to that of the definitive sympathetic in other vertebrates was not discovered till many years later by His. Subsequent writers have all supported his findings, but hitherto all have failed to discover any genetic continuity between the two formations. Ganfini (**5**), in his paper on the sympathetic in birds, seems to have observed the relations more successfully than his predecessors, but he failed to discover the origin of the secondary ganglia from the dorso-lateral processes of the primary ganglia. He follows his predecessors in deriving them immediately from the dorsal root ganglia, for he writes: "Alla formazione del cordone simpatico primario segue la formazione di un

Text-figure 20.



Transverse section of Sparrow 69 (= 8-day chick), showing the differentiation of cells of the dorsal root ganglion (*D.R.G.*) and of the secondary sympathetic ganglion (*Sy.G.*). *Sp.N.* Spinal nerve.

cordone simpatico secondario. Questo è formato da una serie di gangli situati ognuno a livello della parte del tutto prossimale del nervo spinale ed originati da neurociti derivanti esclusivamente dai gangli spinali. . . . Da ogni ganglio simpatico secondario si diparte un ramo che dirigendosi ventralmente e medialmente connette il cordone simpatico secondario col primario." From the last statement he appears to have observed connections proceeding *from* the secondary *to* the primary ganglia, while our graphic reconstructions show exactly the opposite.

The nearest approach to correct observation seems to have been made by Miss Williamina Abel (**1**), though curiously enough she attached little importance to it. In her paper we read:

"At 144 hours the permanent ganglia appear as small clusters of nerve cells, lying close to the mixed spinal nerves and connected to them by fibrous *rami communicantes*. These ganglia increase rapidly in size and are formed largely from the sympathetic cells which have accumulated between the spinal nerves and the temporary (*i.e.* primary) sympathetic chain. Some of the cells of the temporary sympathetic chain are also incorporated in the permanent (*i.e.* secondary) ganglia. Besides these the permanent ganglia are formed from the cells which have migrated directly to them along the spinal nerves. That portion of the temporary sympathetic chain which is not incorporated in the ganglia of the permanent chain gradually atrophies and disappears."

Our observations therefore agree with Miss Abel's in so far as they confirm the importance of the contribution from the primary to the secondary chain. They differ, in assigning a definite form to the accumulations of which she speaks, and in demonstrating definite paths by which this contribution is effected, *i.e.* the dorso-lateral prolongations from the primary ganglia. Moreover, from the marked differentiation of the spinal nerve cells from those of the sympathetic ganglia already described, we question the existence of small clusters of nerve cells lying close to the mixed spinal nerve, in so far as she derives them from the spinal nerve directly. At the time when such clusters do occur they will be found to consist of small cells with dark nuclei containing many granules. We cannot see how such a metamorphosis should occur in the short passage from the dorsal ganglia, all the cells of which are large, with pale nuclei and containing many granules. It seems more probable that the whole definitive sympathetic ganglion arises from the primary sympathetic chains by migratory cells, and by active mitosis, which latter can always be observed in these ganglia.

As to the fate of the primary sympathetic, Miss Abel is in accord with previous writers, all of whom express the opinion that in the course of further development it atrophies and disappears. Our material does not attain a sufficiently advanced stage for us to express a definite opinion on this question, but there are clear evidences of its presence in the oldest stage we have observed, Sparrow 69 (= 8-day chick). The definitive sympathetic chain in the cervical region of this embryo runs in the vertebrarterial canal. Between the vertebræ of the hinder part of the neck, small bundles of fibres emerge and run ventrally, but closely apposed to the cartilaginous vertebral column; these fibres enter large and distinct medial ganglia, lying just under the vertebral column, and above the carotids. In Sparrow B, a little younger, three such medial ganglia are specially noticeable (see text-fig. 11). Longitudinal fibres run from these ganglia to the tissues lying between them, which are highly vascular, being traversed by a capillary plexus linked up with the carotids. The ultimate destiny of these ganglia awaits further investigation.

Apart from them the primary cords are so reduced, by the migration above described, that they may be considered to be wholly absorbed by the definitive sympathetic nervous system. It should be stated that the primary sympathetic chain contributes also to the formation of cœliac and other ganglia, thus the degeneration of the primary sympathetic chains, described by previous writers, should rather be termed a migration from the primary location.

We are unable to assign a cause for this migration of the primary sympathetic chains from the dorso-lateral angles of the aorta to their definitive position, as secondary sympathetic chains in the vertebrarterial canal. Thébault, in his description of the sympathetic system in adult birds, suggests that the long thin neck of the bird renders the sympathetic liable to lesions; hence he explains its inclusion in the vertebrarterial canal. If this be the case, we may regard the definitive location as an adaptive modification. It is perhaps worth notice that the reptile in which primary and secondary sympathetic chains have also been described, viz. the tortoise, is also endowed with a long and flexible neck.

In conclusion, we would express our gratitude to Professor J. P. Hill, F.R.S., for his generosity in supplying us with such an abundance of excellent material and for much assistance in the course of our work and in the preparation of this paper. We are indebted to Professor D. M. S. Watson, F.R.S., for friendly criticism and for aid in final preparation for the press.

I. *Summary*.

1. The primary sympathetic primordia originate from the spinal cord, and are hence ectodermal in origin.

2. The primordia of the ganglia of the primary sympathetic chain are laid down metamerically at inter-somitic points.

3. The constituent cells of the primordia are derived from

   a. The neural crest;
   b. The dorsal root ganglia;
   c. The neural tube by way of the ventral root.

4. The primordia extend cranially and caudally to form a continuous chain on either side.

5. The primary ganglionic swellings extend dorso-laterally. The free ends of these extensions enlarge and becoming separated from the primary ganglia give origin to the definitive sympathetic ganglia.

6. As in the case of the primary ganglia these definitive ganglia extend cranio-caudally and unite to form a continuous chain.

7. The primary sympathetic gives origin to

   a. The secondary sympathetic chains;
   b. The chromaffin cells of the medulla of the suprarenal body;
   c. The cœliac and other ganglia;
   d. The unpaired ganglia in the cervical region.

K. *Bibliography.*

A very full bibliography of the development of the sympathetic nervous system up to the year 1905 will be found in Hertwig's 'Handbuch der vergleichenden und experimentellen Entwickelungslehre,' Band ii. Teil iii.

More recent contributions to the literature are given by Goormaghtigh and also by Da Costa in the papers cited below.

The following are the works to which reference is made in this paper:—

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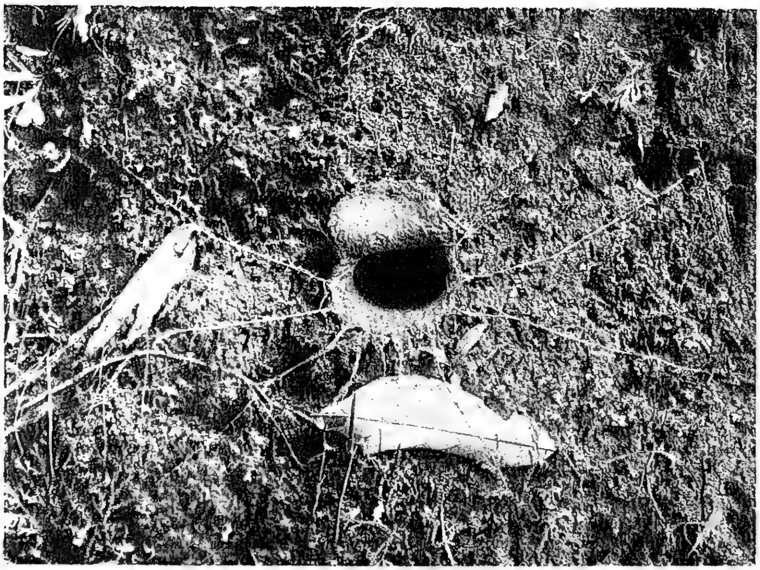
1.



Photos. F. de la Mare Norris.

2.

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NEST OF LIPHISTIUS MALAYANUS, sp. n.

37. A new Spider of the Genus *Liphistius* from the Malay Peninsula, and some Observations on its Habits. By H. C. Abraham, F.Z.S., F.L.S.

[Received May 25, 1923: Read October 23, 1923.]

(Plate I.; Text-figure 1.)

I have recently received, through the courtesy of Mr. F. de la Mare Norris, of the Department of Agriculture, Federated Malay States, a specimen* of the female of a large species of *Liphistius*, together with the trap-door and portion of the silk lining of its burrow, photos of the burrow *in situ*, and notes of a number of observations on the habits of the spider.

In the preamble of a former paper † I mentioned having seen a photo of the present species, and, at that time, I was under the impression that it would turn out to be *L. birmanicus* Simon, but since I have had the opportunity of examining the spider itself I have, rather reluctantly, come to the conclusion that it must be referred to a new species which appears, however, to be very closely related to the above-mentioned.

My reasons for this are, briefly, as follows:—

(*a*) In *birmanicus* the legs of the 1st, 2nd, and 3rd pairs are subequal, the difference in length (coxæ excluded) between legs i and iii being only 1 mm., with a difference of 0·25 mm. between i and ii; whilst in the species described below the difference between i and iii is 4·8 mm., whilst that between legs i and ii is 0·7 mm.

(*b*) In *birmanicus* the 4th leg is rather less than 3 times as long as the cephalothorax, in my specimen it is nearly 3·5 times as long. Similarly, the 1st leg is nearly 2·25 times as long as the cephalothorax, instead of slightly over twice, which is the case in *birmanicus*.

(*c*) The palp (♀) is nearly twice as long as the cephalothorax instead of being a little more than 1·5 times as long.

(*d*) The superior claws of the legs have 2–3 teeth instead of 3–4; also the inferior claws of the legs and the palpal claws have 1–2 very small teeth instead of 2–3 small ones.

In other words the legs and palpi are much longer in proportion to the size of the cephalothorax than is the case in *L. birmanicus*, and furthermore there is a greater diversity in the lengths of the legs, especially noticeable in those of 1st, 2nd, and 3rd pairs.

* Unfortunately in a somewhat damaged condition.

† "A New Spider of the Genus *Liphistius*," Journ. Malayan Branch, Royal Asiatic Soc. i. p. 13 (1923).

Before going on to the detailed description of the spider for which, as it appears reasonable to suppose that it is the usual jungle species of the genus in the southern part of the Malay Peninsula, I propose the name *Liphistius malayanus*, I wish to record my indebtedness and express my thanks to Messrs. H. R. Hogg and F. de la Mare Norris; to the former for much help and advice, and to the latter for having given me the opportunity of examining and writing up this extremely interesting spider as well as for kindly allowing me to make use of the excellent photos which illustrate the description of the burrow and trap-door.

Family Liphistiidæ.

Genus Liphistius Schiödte.

Liphistius Schiödte, in Kröyer Naturh. Tijdsk. 2, ii. p. 621 (1849); Simon, Hist. Nat. des Ar. i. p. 64 (1892), ii. p. 875 (1903).

Liphistius malayanus, sp. n.

Female.—Colour: Cephalothorax and mandibles black; fangs dark reddish brown; labium and coxæ of palpi brownish; coxæ and sternum dark grey, nearly black; legs and palpi black above, dark grey (nearly black) below, with undersides of "joints" nearly white and sides of femora greenish; abdomen black, opercula and fringes of spinnerets brown.

Cephalothorax.—About $1\frac{1}{4}$ times as long as broad, narrower in front than behind, with the cephalic region rather more elevated than is shown in Cambridge Natural History, Arachnida, fig. 201, p. 386, or Fauna Brit. Ind., Arach., fig. 52, p. 155. There are signs of a longitudinal series of bristles having existed on the caput, behind the ocular tubercle. A number of bristles also project forward from the anterior margin, below the ocular tubercle, the median ones being by far the longest.

Eyes.—Closely grouped on a circular tubercle which is higher in front than behind and situated close to the front margin of the cephalothorax on a distinct declivity (text-fig. 1 *a* & *b*).

The anterior laterals are considerably larger than the rest, semicircular in shape, and contiguous, with their lower margins occupying all the front half of the margin of the tubercle; the posterior laterals, next in size, touch the hind margins of the anterior laterals, are also nearly semicircular but rather pointed behind, and occupy the remainder of each side of the tubercle; the posterior medians are oval, rather pointed behind, and about $\frac{3}{4}$ as wide as long, they are situated above and between the posterior laterals with their rear ends level with the middle of the latter and the front edges a little in advance of the level of the hind margins of the anterior laterals; the anterior medians are quite small, between the front margin of the posterior medians and the upper edge of the anterior laterals and separated by about their own diameter from each other and from the front of the posterior medians: they are each placed on the top of a small tubercle (text-fig. 1 *a*).

The eyes are brown except the anterior medians which are black.

The ocular tubercle has a longitudinal median row of 4 or 5 curved bristles, and there are two more bristles near the inner hind margin of each posterior lateral eye.

Mandibles.—Stout, about 2/5 as long as the cephalothorax. The falx is strongly arched anteriorly, strongly convex on the outside but hollowed at the base towards the lower edge, the inner surface is flat. The anterior and upper surfaces are clothed with slightly curved bristles which are longest along the inner front margin.

Text-figure 1.

(a).- Profile. (b).- From above.

Eyes of *Liphistius malayanus*, sp. n.

The fang-groove has a fringe of reddish hair; the inner margin is armed with 10 or 11 stout, bluntly-conical teeth, of which the 2nd, 4th, and 8th are larger than the remainder, which are irregular in size.

The fang is slightly curved, long, and stout, with slight longitudinal striations along its upper surface.

Labium.—About twice as broad as long, the length being equal to the breadth of the anterior margin of the sternum. It is rounded anteriorly and provided with numerous slender curved bristles. It is sunk below the level of the coxæ, of which the basal ends of the 1st pair close in behind it.

Sternum.—Long and narrow, and sunk much below the level of the coxæ of the legs, of which the basal ends approach one another over it; about $3\frac{1}{2}$ times as long as its greatest breadth, which occurs between coxæ ii and iii. In the only specimen available the posterior end of the sternum is somewhat damaged, but the remaining part appears to have been clothed with bristles.

Legs.—Compressed so as to make them squarish in section, this is particularly noticeable in the femora, metatarsi, and tarsi; clothed with numerous black bristles arranged in longitudinal rows. In addition to this there are a number of spines which are distributed as follows:—

The femora have two on the upper surface near the apex and a row along each lower margin.

The patellæ have a row along the anterior upper margin, those at the apex being the longest and curved.

The tibiæ have a series along each lower margin (5 in i and iii, 6 in ii, and 4, much finer, in iv; the basal one in each case much smaller than the others), as well as an apical spine on each side and a number of curved ones along the front margins.

The metatarsi of the 1st and 2nd pairs have 7 stout spines along each lower margin, and one at the apex on the inner side; on the 3rd and 4th pairs there is, in addition, an apical spine on the outer side and 3, rather finer, along each upper margin.

The tarsi have a row of stout spines along each lower margin (7 or 8 along the front, 6 or 7 along the posterior); there are also 3 or 4 small spines in a transverse row on the underside at the base and about 4, also small, arranged in a V just below the inferior claw and apparently intended to fulfil, to some degree, the functions of ungual tufts or scopulæ.

The superior tarsal claws are long, well curved, and stout; they are armed on the basal half with 3 teeth, except in the outer one of the 1st and 2nd legs, where there are only 2 teeth; in the claws of the 4th pair all the teeth are long, sharp, and subequal, but in the other cases where 3 teeth occur the basal one is very small.

The inferior tarsal claws are armed with 1 or 2 very small teeth.

Palpi.—Very similar to the legs both in general appearance and armament.

The coxæ have a thick fringe of long reddish curved hair along the inner margins.

The femora have a series of slender spines along each margin of the underside, as well as a single spine near the base and 2 or 3 near the apex on the upper surface.

The patellæ have a spine on the lower inner margin near the distal end and also show signs of having had 2 or 3 on the upper surface near the apex.

The tibiæ have 5 stout spines along each margin of the underside, and also have a series of 3 along the inner surface.

The tarsi have 7 long stout spines along each margin of their lower surfaces.

The claw is stout, slightly curved, and armed with 2 very small teeth near the base.

Abdomen.—Apparently oval in shape and about $1\frac{1}{2}$ times as long as wide (the abdomen of the only available specimen is, however, somewhat shrivelled, so that these proportions may not be accurate). It is furnished with 9 distinct dorsal terga, and there is a rudimentary 10th one midway between the 9th and the anal tubercle. The 4th tergum is the largest and the 9th the smallest. The sides and lower surface of the abdomen are wrinkled and thickly clad with bristly hairs; there are signs also of the terga having been armed with bristles along their posterior margins.

The spinnerets form a compact group about the middle of the lower surface of the abdomen, the base of the anteriors being almost exactly midway between the base of the abdomen and the anal tubercle. They are typical in form with the basal segment of the posterior laterals about half the diameter of that of the anterior laterals, and the anterior medians a little larger than the posterior medians. The apical segments of the laterals are divided into about 12 false articulations. The anterior laterals are separated at the base by about half their basal diameter; and their apices reach a point halfway between the anterior margin of their base and the anal tubercle. The anterior medians are close together and just in front of the anterior laterals, whilst the posterior medians, also contiguous, are situated between the two pairs of laterals. The bases of the posterior laterals are close together and their distal extremities are curved inwards similarly to those of the anterior laterals. The inner margin of the apical segments of all the laterals is furnished with a fringe of coarse brownish hair.

The anal tubercle is conical, clothed with black bristles and situated a little way in front of the posterior end of the abdomen.

Measurements (mm.).

	Length.	Breadth.
Cephalothorax	13·2	10·6
Abdomen	13·2	(8·6) *
Falx	5·5	...

Lengths of	Coxæ.	Tr. & fem.	Pat. & tib.	Met. & tar.	Totals.
Legs I	6·0	10·3	10·6	8·2	35·1
II	5·7	10·2	10·6	9·0	35·5
III	6·0	11·6	11·2	11·1	39·9
IV	6·4	14·3	13·4	17·5	51·6
Palpi	4·5	9·3	9·4	6·0	29·2

* Approximate only, abdomen somewhat shrivelled.

Habits *.—This spider inhabits web-lined burrows fitted with a trap-door of the wafer type. The burrows, which are about 28 mm. in diameter and 400 to 450 mm. long, are found, from the examination of about 20 examples, to be horizontal in general direction, but usually are somewhat bent so that a straight stick cannot be thrust in very far; they are unbranched and the inner end is somewhat enlarged. The trap-door is invariably hinged to the mouth of the tube at the upper edge, and another very interesting fact is that the lines of web, which in *L. batuensis* Abr. are employed to support the nest upon the vertical cave-walls †, are by the present species used to keep the web-lining stretched over the edge of the burrow so as to form a "lip" against which the lid can close down tightly; this may be seen very clearly in Plate I. fig. 2, in which the lid is shown in the opened position. All the burrows found so far have had their openings on practically bare banks with perhaps a few small ferns, etc. growing near, but, as all bare banks in this country are artificial cuttings, and those in question have been made within the last 20 years or so, it is almost certain that the spider must live in the jungle on the neighbouring hills. The trap-doors of the observed burrows all have small stones and particles of earth woven into them.

The spider appears to be entirely nocturnal, as pins placed in front of the entrances of burrows were never disturbed during the day, but have always been pushed out of position during the night; the spider also seems quite "lost" in bright light. It does not appear to be common as, in annual visits to the hill upon which it was found from 1918 to 1922 inclusive, only comparatively few individuals—not more than about 20 altogether—have been observed. As is generally the case with burrowing spiders, *L. malayanus* occupies the same nest for a long time; in fact, it probably does not change its quarters unless forced to do so.

Locality.—Gunong Angsi, Negri Sembilan, F.M.S.; 2500 feet. December 1922 (*coll. Mr. F. de la Mare Norris*).

Specimens examined.—One adult female, which I have sent to the British Museum, Natural History Department ‡.

* From notes of his field observations kindly supplied by Mr. F. de la Mare Norris.

† Abraham, *l. c. supra*, p. 19, and plate i. fig. 2.

‡ Together with its trap-door.

38. A Review of the Lizards of the Genus *Tropidophorus* on the Asiatic Mainland. By Malcolm A. Smith, M.R.C.S., L.R.C.P., F.Z.S.

[Received May 28, 1923: Read October 23, 1923.]

This article concerns those species that are to be found distributed throughout the Indo-Chinese peninsula—Burma, Siam, and French Indo-China—and the region immediately north—Assam, Yunnan, and southern China. Incidentally it completes our knowledge of the whole group, the species of the Indo-Australian region and of the Philippine Islands having been recently undertaken by Nelly de Rooij * and Edward H. Taylor † respectively.

The whole genus now includes some 18 species. It is essentially a highland one, and is largely aquatic in its habits. Its members are to be found in the vicinity of rocky streams, living among the damp herbage on the banks, or hiding under stones and boulders, sometimes almost completely immersed in the water to which they invariably take to avoid capture. They are nocturnal in their habits and are not remarkably agile. One species, *T. microlepis*, I have found to be viviparous.

Different characters have at times been used to group the species, but the one, so far neglected, which appears to me to present the most natural basis for classification, is the manner in which the scales are disposed along the sides of the body. It divides the genus into two broad groups: (1) those with the lateral scales directed straight backwards, with smooth or keeled dorsal scales and smooth or feebly rugose upper head-shields, and (2) those with the lateral scales directed obliquely upwards and backwards, with strongly keeled, often mucronate dorsal scales and with head-shields always rugose.

The præanal shields vary in number, but appear to be constant as regards each species. On the other hand, the number of scales round the body shows considerable individual variation, and unless some other differential character can be shown to exist, does not seem sufficient for specific distinction.

In coloration the species are all much alike.

Within the geographical limits discussed in this paper I recognize the following forms:—

I. Lateral scales directed straight backwards.
- *a.* Head-shields smooth.
  - Fronto-nasal entire .... *T. berdmorei.*
  - Fronto-nasal divided .... *T. laotus.*
- *b.* Head-shields feebly rugose .... *T. robinsoni.*

* 'Reptiles of the Indo-Australian Archipelago,' 1915.
† 'The Lizards of the Philippine Islands,' 1922.

II. Some or all of the lateral scale-rows directed obliquely.

a. Two præanal shields.

Frontal and fronto-nasal entire, 4th supralabial largest, dorsal scales strongly mucronate	*T. assamensis.*
Frontal and fronto-nasal entire, 4th supralabial largest, dorsal scales not mucronate, median row bicarinate	*T. hainanus.*
Frontal and fronto-nasal entire, 5th supralabial largest	*T. cocincinensis.*
Frontal entire, fronto-nasal divided	*T. sinicus.*
Frontal and fronto-nasal divided	*P. thai.*

b. Three præanal shields .... *T. microlepis.*

The separation of many of the forms here mentioned is extremely slight, and depends sometimes upon a single scale-character. Most of them have a limited range of distribution, and, so far as I am aware, no two forms have yet been found in the same locality.

1. Tropidophorus berdmorei.

Aspris berdmorei Blyth, Journ. Asiat. Soc. Bengal, 1853, xxii. p. 651.

Tropidophorus berdmorei Theob. Journ. Linn. Soc. 1868, p. 24; Anderson, Zool. Res. Yunnan, 1878, p. 796, pl. lxxvi. fig. 3; Bouleng. Cat. Liz. Brit. Mus. 1887, iii. p. 362; Annandale, Rec. Ind. Mus. 1912, viii. p. 59; Mlcm. Smith, Journ. N. H. S. Siam, 1919, iii. p. 225.

Tropidophorus yunnanensis Bouleng. Cat. Liz. Brit. Mus. 1887, iii. p. 362; Mlcm. Smith, Journ. N. H. S. Siam, 1919, iii. p. 224.

Through the kindness of Dr. Annandale, Director of the Indian Museum, I have been able to examine the types—three in number—of this species. The specimens are somewhat faded but are otherwise in excellent preservation. One has 32 scales round the middle of the body, the other two have 34 each. In the two smaller specimens the dorsal scales are distinctly, but not strongly keeled, in the largest one I cannot find any keels at all. Anderson, when comparing these types with his specimens from Yunnan *, states that he found keels on all three, and, except for this difference in the carination of the scales, they agreed entirely. He therefore labelled the Yunnan specimens *berdmorei*. This view should certainly be maintained, and *T. yunnanensis*, founded later evidently on a misunderstanding, became a synonym of it.

My own collections of this lizard from Siam, supplemented by an excellent series from Burma in the Indian Museum, have enabled me to examine a large number of specimens. In the number of scales round the body, and in the degree of carination

* The Yunnan specimens are now lost. Dr. Annandale tells me he has never been able to discover what happened to the types of Anderson's reptiles and batrachians. Many of them never seem to have been incorporated in the Museum collection.

of the dorsal shields, they show considerable variation, but I cannot find any satisfactory combination upon which they can be racially separated. Some have the scales smooth, some have them faintly keeled, others more strongly. Each locality has its own slight variation. Where one adult has smooth scales, all the other adults from that place have the same, and *vice versa*.

All the Burmese examples have two loreal shields, one behind the other. Most of the Siamese individuals have three, the anterior one being divided horizontally. The præfrontal shields may be in contact, or separated, or have a small shield interposed between them, irrespective of locality.

The following table shows the variation in the specimens I have examined :—

BURMA.		SIAM.	
Locality.	Scales.	Locality.	Scales.
Mergui	32–34	S. of Utaradit.	32–36
Tenasserim	36–40	Doi Nga Chang, N. Siam.	36–38
Takoo Mts., Central Tenasserim.	36–38	Me Wang forest, N. Siam.	32–36
Pegu.................. ...	40	...	...
Bia Po, Karin Hills ...	34	...	...
Bhamo	32	...	...

The allied Bornean *T. beccarii* (Peters) appears to have a variation similar to that of *T. berdmorei*, and *T. mocquardi* Boulenger should, in my opinion, be united with it. The specimens in the British Museum show the range in scale-rows to be from 28–36 round the body; apart from this I can find no character upon which they can be separated.

2. Tropidophorus laotus, sp. n.

Types. Adults ♂ and ♀, author's Nos. 5410 and 5414, collected at Muang Liep, N. of Pak Lai, Upper Mekong, French Laos, in January 1920. Presented to the British Museum (Natural History).

Description of the types.—Upper head-shields smooth; a pair of fronto-nasals, each one longer than broad: præfrontals separated by a small azygos shield; frontal as long as the parietal and fronto-parietal together; parietals in suture behind the interparietals; 4 supraoculars, 1st largest, 1st and 2nd in contact with the frontal, 4th entering the supraciliary border; nostril in a single shield; two superposed anterior loreals, succeeded by a larger posterior one; 6 supralabials, 4th largest and forming subocular; 5 infralabials, the first longest and in contact with the postmental and first chin-shield; temporals small and like the body-scales, except the superior, which is much larger; a single postmental succeeded by two pairs of large shields. Tympanum as large as the eye-opening.

Thirty-three scales round the middle of the body in the ♂, 34 in the ♀, all quite smooth; ventrals largest, laterals smallest and directed straight backwards; a pair of enlarged præanals; a series of enlarged scales beneath the tail. The hind-limb reaches the wrist in the ♂, and not quite so far in the ♀; subdigital lamellæ smooth, 18 to 20 beneath the 4th toes.

Dark brown above, with lighter black-edged V-shaped bars; sides of body with small white spots; below whitish, throat and tail thickly spotted with black.

Variation.—The azygos shield separating the præfrontals varies in size, and may be absent, when either the præfrontals are in contact or the frontal touches the fronto-nasal. 32 scales round the body occurs in nearly half the series. In one example (No. 5416) there are only 30 scales. In the young the dorsal scales are faintly keeled, and the limbs are proportionately longer, the leg reaching the wrist or the elbow of the adpressed fore-limb.

T. laotus is identical with the smooth-scaled form of *T. berdmorei* except for the divided fronto-nasal. Two examples (Nos. 5412 and 5425 from Muang Liep and Nong Kai respectively) have the fronto-nasal single as in true *berdmorei*; but with so large a series at hand I prefer to regard them as aberrant examples of *T. laotus*.

Sixty-eight specimens examined, from Muang Liep, Nong Kai, Pak Maat, Pak Men, and Hoi King, all localities on the Mekong river, to the north and south of, and within 80 kilometres of, Pak Lai.

Adult males can be recognized from females by the broader head at the angle of the jaw. Most of the old males also have the head-shields considerably scratched and scarred, and I gather from this that a considerable amount of fighting amongst themselves takes place.

Measurements of specimens of T. laotus *in mm.*

Author's No. ...	5410	5414	5411	5415	5440	5417	5424
Head and body	71	71	74	75	75	51	40
Tail	95	105	100	96	105	82	62
Length of head	18	17	17	17	19	13	11·5
Width of head	12	10	11	11	12	8	6·5
Fore-limb	20	19	20	20	21	14	12
Hind-limb	30	27	28	30	31	21	18
Sex	♂	♀	♀	♀	♂	juv.	juv.
No. of scales	33	34	34	34	32	32	32

3. TROPIDOPHORUS ROBINSONI.

Tropidophorus robinsoni Mlcm. Smith, Journ. N. H. S. Siam, 1919, iii. p. 223.

Besides the large series from the type-locality there are six specimens from Tavoy, Tenasserim, in the Indian Museum (Nos. 12722–12727). They agree with the types in every respect.

4. Tropidophorus assamensis.

Tropidophorus assamensis Annandale, Rec. Ind. Mus. 1912, viii. p. 58.

Still known only from the type-specimen, which I have examined. From *T. cocincinensis* it differs in having the 4th supralabial largest and below the middle of the eye, in having no small shields interposed between the loreals and supralabials, and in the strongly mucronate dorsal scales. It has one large anterior and one posterior loreal scale. The ventral keeling is probably an immature character as the specimen is not yet fully grown.

5. Tropidophorus hainanus, sp. n.

Type. Author's number 6997, collected at Ang Mao, alt. 600 m., near the Five Finger mountain, island of Hainan, in January 1923. Presented to the British Museum (Natural History).

Description of the type.—Upper head-shields strongly striated; fronto-nasal single, as long as broad, in contact with the frontal; frontal once and two-thirds longer than broad, as long as the fronto-parietal and interparietal together; parietals in contact behind the interparietal; 4 supraoculars, the anterior two touching the frontal, the fourth just entering the supraciliary border; 5 supraciliary shields anterior to the fourth supraocular; nostril in a single shield; two anterior and two posterior loreal shields; temporals small, with strong striæ like the upper head-shields; 6 supralabials, the fourth largest and below the middle of the eye; 5 infralabials, the first in contact with the azygos postmental and anterior chin-shield. Tympanum as large as the eye-opening.

Thirty-two scales round the middle of the body; dorsals and laterals strongly keeled, not mucronate, most of the scales in the median dorsal row with two keels, or where unicarinate smaller than the others; laterals smaller than the dorsals, the upper rows with a feeble obliquity upwards and backwards; ventrals larger than the dorsals, quite smooth; gulars feebly keeled; a pair of enlarged præanals; three rows of smooth scales below the tail, the median row transversely enlarged. The hind-limb reaches the wrist.

Dark reddish brown above, with indistinct light dark-edged cross bars, the anterior two V-shaped; flanks with large whitish dark-edged blotches; belly white speckled black; throat with white longitudinal streaks.

Variation.—Six specimens examined from the type-locality (Nos. 6996 to 7001), and one (No. 7002) from the foot of the Five Finger mountain about 20 miles distant.

The præfrontals are separated in every example; there are seven supralabials in No. 7002, the 5th being below the middle of the eye; one specimen has only 30 scales round the body, another has 34; in some examples only a few scales of the median dorsal row are bicarinate; in two juveniles the ventral scales are feebly keeled; the hind-limb may reach the elbow. Two examples are light brown in colour, with the usual markings.

Although Hainan is not the mainland of Asia, the fauna of the island is so closely related to that of Indo-China, that this species should be included here.

Measurements of specimens in mm.

No.	6997	7001
Length of head and body	47	49
Tail	60	55
Fore-limb	13	12
Hind-limb	20	18

6. TROPIDOPHORUS COCINCINENSIS.

Tropidophorus cocincinensis Dum. & Bib. 1839, v. p. 556, pl. lvii. fig. 1.

Tropidophorus cochinchinensis Bouleng. Cat. Liz. Brit. Mus. 1887, iii. p. 363 (in part).

The types, three in number, two adults and one juvenile, are in the Paris Museum. M. Angel has kindly examined them for me, and has given me the following particulars.

They have 30 and 32 scales round the body, the laterals a little smaller than the others. Dorsal, lateral, ventral, and gular scales keeled in the young example, the ventral and gular smooth in the adults. Two large præanal plates. Tail longer than the head and body. Caudal scales strongly keeled except for the three median lower rows. The fifth supralabial is largest and below the middle of the eye, and there are small scales interposed between the supralabials and the loreals.

The exact type-locality of *T. cocincinensis* is unknown; it is said to have come from Cochin-China, but in view of the known range of *T. microlepis* it seems probable that it came from farther north.

7. TROPIDOPHORUS SINICUS.

Tropidophorus sinicus Boettger, Zool. Anz. 1886, p. 519; Bouleng. Cat. Liz. Brit. Mus. 1887, iii. p. 362; A. Mell, Archiv für Naturgesch. 1922, 10 Heft, p. 114.

The type-locality is near Canton, and it has also been found in the Man Son Mts., Tonkin.

I recently obtained two half-grown specimens on the Peak in Hongkong. They have 30 scales each round the middle of the body, the laterals and dorsals strongly keeled and feebly mucronate, the ventrals feebly keeled; loreals 1+1; 5 infra-labials, the first long and in contact with the divided post-mental and first chin-shield. Belly in life salmon-pink.

8. Tropidophorus thai.

Tropidophorus thai Mlcm. Smith, Journ. N. H. S. Siam, 1919, iii. p. 226.

Habitat. N. Siam. Still known only from the original specimens.

9. Tropidophorus microlepis.

Tropidophorus microlepis Günther, P. Z. S. 1861, p. 188; id. Rept. Brit. Ind. 1864, p. 76, pl. x. fig. A.

Tropidophorus cochinchinensis (in part) Bouleng. Cat. Liz. Brit. Mus. 1887, iii. p. 363; Mlcm. Smith, Journ. N. H. S. Siam. 1919, iii. p. 227.

As already stated, the præanal shields appear to be constant in number as regards each species, and in 19 examples of *T. microlepis* from the type-locality I find 3 præanal shields in every instance. Another specimen from Dran, on the Langbian plateau, S. Annam, has also 3 præanal shields, and agrees in all other respects with the topotypes.

With so important a character to guide one it is justifiable to maintain Günther's species, and to keep it distinct from *cocincinensis*, the three type-specimens of which have only two præanal shields each.

In *T. microlepis* the dorsal and lateral scales are all strongly keeled and spinously produced, all of the lateral rows, except the lowest, being obliquely directed. The first lower labial is very small, allowing the second labial to make broad contact with the post-mental.

39. On the Larval Anatomy of the Gout-Fly of Barley (*Chlorops tæniopus* Meig.) and two Related Acalyptrate Muscids, with Notes on their Winter Host-Plants.

By J. G. H. FREW, M.Sc. (Birmingham), F.Z.S., Ministry of Agriculture Research Scholar.

[From the Entomological Department, Rothamsted Experimental Station, Harpenden].

[Received June 4, 1923: Read October 23, 1923.]

(Text-figures 1–23.)

TABLE OF CONTENTS.

Introduction.

The following paper deals with the preliminary work done in the course of an investigation on the life-history, possible means of control, etc., of *Chlorops tæniopus*, the gout-fly of barley. The investigation was commenced in October 1921 under the direction of Dr. A. D. Imms. At the beginning of the work a search was made through the literature of the subject to find a recognisable description of the larva of *Chlorops*, but no such description could be found. Gout-fly is usually easily recognisable by the type of damage which it causes to the barley (or other host-plant). This, however, is not always the case and one has, fairly frequently, to depend on the morphology of the larva itself for certain diagnosis of the cause of damage to the host-plant. A description of the morphology of the larva seems therefore to be desirable, as relatively little is known concerning the morphology of Acalyptrate larvæ. The internal anatomy of the larva of *Chlorops* is also dealt with in this paper.

During the winter 1921–22 an extended series of examinations of various grasses was made primarily in order to discover the winter hosts of the gout-fly. During this grass examination several other Acalyptrates besides *Chlorops* were bred out, and the larval forms of two of them are described briefly at the end of this paper. Although these larvæ normally pupate within their host they will, if removed towards the end of their larval period when they have finished feeding, pupate and complete their emergence if placed on moist filter-paper in glass tubes. In this way one can be quite certain which larva is being bred out.

For the investigation of the internal anatomy of the larva of *Chlorops* both dissections and serial sections were made. A certain amount of the internal anatomy of the larva can be made out in a living larva in a drop of salt solution, a method useful in checking results obtained by other means.

I wish to express my indebtedness to Dr. A. D. Imms for help and advice in all branches of this investigation. To Dr. W. E. Brenchley I am indebted for her kindness in identifying all grasses examined during the difficult winter period when only the vegetative characters were available. For the identification of the imagines bred out I have to thank Mr. J. E. Collin.

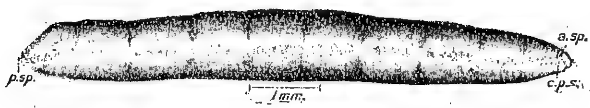
Chlorops tæniopus Meig.

A. *External Anatomy of Larva.*

The following description applies to the third instar larva of either the winter or summer generation; the points in which the first and second instars differ anatomically from the third will be indicated later.

The full-grown larva (text-fig. 1) is approximately cylindrical, about 6·3 mm. long and 1·2 mm. in diameter in the posterior region of the third thoracic segment. At the latter region the diameter tapers off rather rapidly anteriorly to the minute head and very slightly and gradually posteriorly to the rounded anal segment. The larva is apodous and of the usual Muscid type; I consider that it consists of a head, three thoracic and nine

Text-figure 1.



C. tæniopus. Lateral view of mature larva.

abdominal segments. The larva is amphipneustic, the posterior spiracles being at the apices of two very small papillæ carried postero-dorsally by the last abdominal segment. The anterior spiracles lie one on each side, projecting from the first body-segment near its posterior border, slightly dorsal to the mid-lateral line.

The Head (text-fig. 2).

In 1904 Henneguy proposed the term "pseudo-cephalon" for the anterior segment of Muscid larvæ, and Hewitt (1914) follows him in this nomenclature. Becker (1910), however, has shown that the head of a Muscid larva is homologous with the head of such a eucephalous type as the larva of *Simulium*, and there is therefore no valid objection to the use of the term "head" in describing Muscid larvæ.

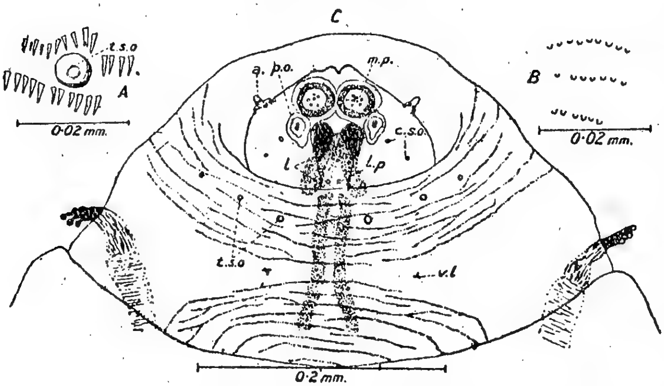
The head is a small rounded body capable of almost complete retraction within the first body-segment. Ventrally it bears several paired sense organs and also the mouth-opening through which project the apices of the mouth hooks; its surface is quite smooth, with none of the chitinous ridges so commonly found on the ventral surface of the head of cyclorrhaphous larvæ.

The most prominent cephalic sense organs are the *maxillary palps* (*m.p.*), each of which consists of a small rounded group of sense papillæ surrounded by a dark brown chitinous ring. Each sense papilla appears in surface view as a small shining ring with a dark central region which is apparently a shallow depression at the apex of the papilla. The two maxillary palps lie close to the anterior border of the mouth with their median borders almost touching. From between the two maxillary palps a median depression runs forwards along the ventral surface of the head dividing it into symmetrical halves; unless the head is almost completely exserted very little of this groove can be seen.

Close to the antero-lateral borders of the mouth there is on each side a *pre-oral sense organ* (*p.o.*). In the majority of cyclorrhaphous larvæ this organ lies anterior to the mouth between the latter and the maxillary palps; its lateral position in *Chlorops* is probably due to the unusually large size of the maxillary palps and their close approximation to the anterior edge of the mouth-opening. Each pre-oral sense organ is a slightly raised papilla bearing several small rounded bodies similar to those on the maxillary palps. According to Keilin (9) the pre-oral sense organ is innervated by a branch of the nerve which supplies the maxillary palps, of which, according to him, it is probably a part.

The position of the *antennæ* (*a.*) is peculiar in being not anterior, but lateral, on a level with the anterior border of the mouth and actually, therefore, posterior to the maxillary palps. Each is two-jointed, the basal joint being little more than a small papilla with a flattened apex. The second joint, which fits into the apex of the first, is a cylindrical body of firm yellow chitin

Text-figure 2.



C. tæniopus. Ventral view of larval head.

A. Thoracic sense organ and neighbouring chitinous denticles.
B. Abdominal chitinous denticles.

with a rounded apex. Internally, at about one-third of its height, the second joint is produced into a circular ledge whose inner edge is bent at right angles towards the base of the antenna. Keilin (9) describes, in connection with the antenna of *Pollenia rudis* Fabr., a "petit batonnet chitineux," one end of which is attached to the outside of the base of the second joint of the antenna while its other end is in connection with a "bulbe nerveux." In a later paper (10) he describes a similar organ in the larval antenna of *Graphomyia maculata* Scop. with the difference, however, that it arises from the inside of the second antennal joint, and he seems to imply that such an appendage to the antenna is universal in Cyclorrhaphous larvæ. I have failed to find this appendage in the larva of *Chlorops* or any other Acalyptrate larva, and although the number of species examined does not at present justify any generalization, it is perhaps possible that the absence of this appendage may be a reliable distinguishing character of Acalyptrate larvæ.

At the posterior border of the mouth is a small lightly chitinized plate (*l.*) bearing two small rounded sense organs (*l.p.*) close to the median line and near the posterior end of the plate. I think there can be no doubt that these sensory organs are the *labial palps* said by Keilin (**9**) to be present in all cyclorrhaphous larvæ which he has examined, though these are in many cases, notably in certain carnivorous Anthomyid larvæ (**10**), much more prominent structures than they are in *Chlorops*. If this terminology is correct the chitinized plate must be considered as a Labium—the presence of which as a distinct sclerite in a cyclorrhaphous larva is of considerable interest.

There are several small sense organs on the surface of the head, and their position is shown in text-fig. 2 (*c.s.o.*). Each is slightly raised above the surface of the head and consists of a minute rounded pit with an encircling chitinous rim.

Body-Segments.

There are twelve body-segments, three thoracic and nine abdominal, the first thoracic and the last abdominal bearing respectively the anterior and posterior spiracles. It is usual in describing Cyclorrhaphous larvæ to distinguish a segment, "Newport's Segment," between the head and the first body-segment, which "is usually invaginated within the first thoracic segment, so that it cannot be seen except when the larva is forcibly extended" (Lowne, p. 34). Lowne (p. 748) failed to find this segment represented in the embryo, and I am unable to find any morphological reason for considering it as other than the invaginable anterior end of the first thoracic segment.

The lines of junction of the body-segments are marked by bands of minute chitinous denticles which completely encircle the body. The bands are not continuous but are formed of short separate series of denticles. The thoracic teeth are long and narrow, pointed posteriorly, and attached by their broad base anteriorly. Very rarely their apices are bifurcated (text-fig. 2 A). The abdominal teeth (text-fig. 2 B) are considerably smaller and approximately semicircular in shape with the flat side attached anteriorly and the rounded apex projecting backwards.

The dorsal surface of the first thoracic segment is completely covered by the rows of chitinous teeth. Ventrally it has a broad anterior band and a narrow posterior band leaving a narrow transverse area between the two which is free from teeth. The second thoracic segment is very similar to the first in the arrangement of the chitinous teeth. The third thoracic segment has a broad band round its anterior border only.

Keilin (**9**) drew attention to the presence on the thoracic segments of the great majority of Cyclorrhaphous larvæ, of two types of sense organs, both of which occur in the larva of

Chlorops. Near the anterior ventral border of each thoracic segment is a transverse series of about six small rounded sense organs (*t.s.o.*). These are similar to, but rather larger than, those occurring on the ventral surface of the head, from which they also appear to differ in being sunk in extremely shallow pits, instead of being slightly raised above the surface. These sense organs have not been found on the dorsal surface of the body. Each thoracic segment also bears two little sense organs at about the middle of the ventral surface, one on each side of the median line (text-fig. 2, *v.l.*). Each consists of three tiny papillæ situated very close together and each bearing a minute stiff bristle. Keilin (9) has established the fact that the peduncles of the imaginal leg rudiments are attached to the hypoderm immediately below these organs which he regards as vestigial legs. I have been able to verify this relationship in the eucephalous larva of *Forcipomyia piceus* Winn, where there is no peduncle to the imaginal discs, but I have failed to do so in *Chlorops*, where the peduncles are extremely long and fine.

Each of the abdominal segments, except the ninth, has a broad band of chitinous teeth round its anterior border. What I regard as the ninth abdominal segment is considerably smaller than any of the others. Ventrally it bears a longitudinal slit, the anus, bordered on each side by a slightly raised rounded lip; postero-dorsally it bears the two posterior stigmatic papillæ. When the larva is fully extended the division between the eighth and ninth abdominal segments is indistinguishable; the ninth segment is, however, capable of being partially withdrawn within the eighth and should, I think, be regarded as a separate segment. This conclusion is strengthened by a consideration of the distribution of the abdominal sense organs in the larva of *Meromyza nigriventris* Mcq., which will be dealt with later. No abdominal sense organs were found in the larva of *Chlorops*.

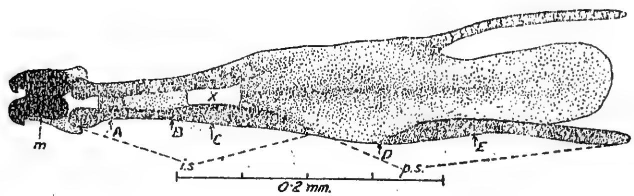
The form of the spiracles is described later in connection with the tracheal system.

B. *Internal Anatomy of Larva.*

The *Cephalo-Pharyngeal Skeleton* (text-figs. 3, 4 & 5, A–E) consists of two *mouth hooks*, an *intermediate sclerite* (*i.s.*) which bears anteriorly an articular surface for each mouth hook, and a large *pharyngeal sclerite* (*p.s.*). The two latter sclerites are fused, but the line of junction is clearly visible owing to the heavier chitinization of the intermediate sclerite. For the sake of convenience the mouth hooks are, throughout this paper, referred to as "mandibles," though it must be understood that no attempt is thereby made to homologize them with the mandibles of Orthorrhaphous larvæ. According to Weismann's embryological work (16) they are entirely new structures. Holmgren (5) considers them to be homologous with the mandibles of Orthorrhaphous larvæ but brings forward no embryological support for his theory, and his comparisons of certain larval types by which he attempts to establish his view are adversely criticised by Becker (1).

Each mandible (*m.*) is a stout, heavily chitinized hook with a pointed claw-shaped anterior end and two posterior processes, a smaller heavily chitinized dorsal one with a rounded posterior surface which articulates with the corresponding articular surface of the intermediate sclerite, and a larger ventral one flattened from side to side, into which are inserted the depressor muscles

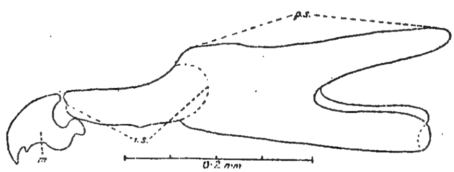
Text-figure 3.



C. tæniopus. Dorso-lateral view of cephalo-pharyngeal sclerites.

of the mandible. At the point of junction of the claw and the anterior end of the ventral process there is a small, less heavily chitinized, but sharply pointed, accessory tooth. The dorsal process is broad from side to side and somewhat flattened dorso-ventrally. It is held in close apposition to the articular surface of the intermediate sclerite by the tension of the depressor and levator mandibular muscles, and when these are cut, or even when the larva is killed, the mandibles very easily come apart from the

Text-figure 4.

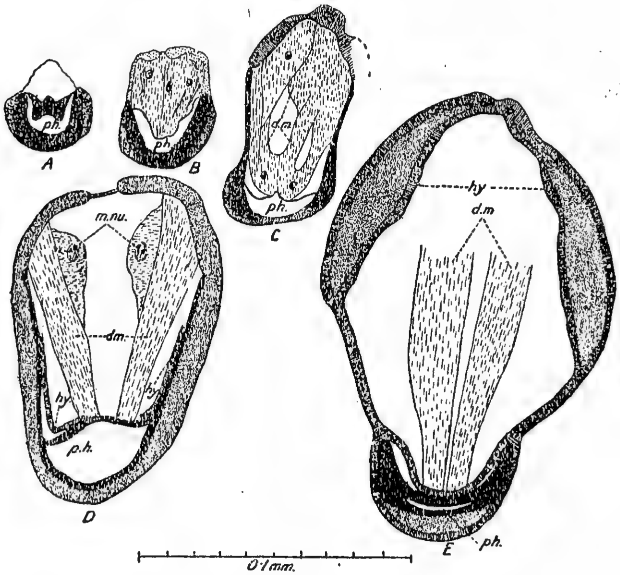


Lateral view of cephalo-pharyngeal sclerites.

intermediate sclerite. The two mandibles are fused together medianly over a small area but their articular surfaces are separate.

The relations of the intermediate and pharyngeal sclerites can best be understood by a reference to text-figs. 3 & 4 and text-fig. 5, A–E, which represents a series of transverse sections through the sclerites at the points marked by arrows on text-fig. 3. As mentioned above, the intermediate and pharyngeal sclerites are fused. The form of the whole compound sclerite is that of a trough with a double ventral wall, the space between the two ventral walls being the cavity of the pharynx. The trough is surrounded by hypodermis and the cavity of the trough, above the pharynx, is also lined by hypodermis, the two layers being continuous round the posterior end of the trough. (This hypodermis is only shown in text-fig. 5, D & E.) The dorsal edges of the trough are joined together by a sheet of hypodermis (which is really double though its double nature is never very distinctly visible in sections) which appears to secrete a thin layer of chitin in places. I consider that this double layer of

Text-figure 5.



Transverse sections through the points marked A–E in text-fig. 3.

Chitin shown black or dotted according to the density of the chitin. Hypoderm and dorsal membrane cross-hatched. The complete hypoderm is shown only in text-fig. 5 E. It is partially shown in 5 D; not at all in the other figures.

hypodermis is homologous with the hypodermal fold in the larva of *Chironomus*, which is derived from the dorsal region of junction of head and neck and extends backwards into the thorax and from which arise the cephalic imaginal discs (**14**). In *Chlorops* the cephalic imaginal discs arise from the posterior end of this double hypodermal sheet. In the region represented by text-fig. 5, A & B, the dorsal membrane is present, but I am very doubtful as to its nature, as I failed to find any hypoderm in connection with it. It may possibly be chitinous, which is certainly its appearance, and may be the result of the complete transformation of the original hypoderm into chitin. Further back (text-fig. 5 C) the dorsal membrane consists only of hypoderm In text-fig. 5 D hypoderm is present (not shown in the figure) and secretes a thin layer of chitin. In text-fig. 5 E, only hypoderm is present.

The dilator muscles of the pharnyx (*d.m.*) arise from the upper parts of the walls of the trough and are inserted into the dorsal wall of the pharynx, which they raise by their contraction, thus enlarging the capacity of the pharynx and sucking up food through the mouth. In the extreme anterior region (text-fig. 5 A) there are no dilator muscles, their space being occupied by a blood-sinus. The posterior end of the pharyngeal sclerite shows two lateral incisions extending far forwards and dividing it into three arms, a ventral one containing the pharyngeal cavity and two solid dorsal ones. Owing to their depth the dorsal arms appear, when viewed dorsally, to be more heavily chitinized than the ventral one; that this is not so is shown in text-fig. 5 E. The hypoderm surrounding the ventral arm is directly continuous posteriorly with the epithelium of the œsophagus.

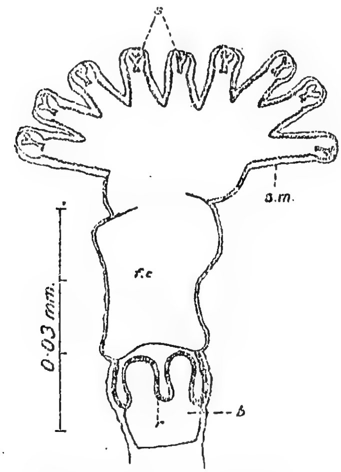
The appearance shown in text-fig. 3 of a hole through the posterior region of the intermediate sclerite is due to the thin ventral walls of the trough at this point (text-fig. 5 C), and the light chitinization of the lower of the two. It is in this region that the salivary duct opens into the pharynx.

The Tracheal System (text-figs. 6 to 10) is of the usual Muscid type, the larva being amphipneustic.

The Anterior Spiracles (text-fig. 6) are of the usual radiating type. The anterior end of the main tracheal trunk expands slightly, forming a small bulbous region (*b.*), the wall of which is strengthened by a ridge (*r.*) formed apparently as a hollow outpushing of the wall, which goes round the bulb, forming alternately anterior and posterior loops. Anterior to the bulb is the short Stigmatic Trunk or Felted Chamber (*f.c.*), the Filzkammer of De Meijere (**6**). This is of somewhat greater diameter than the bulb, and sections show that its lumen is broken up by numerous fine chitinous hairs and ridges arising from its walls. The distal end of the felted chamber expands slightly and, bending upwards at right angles to its proximal portion, projects from the surface of the body in the dorso-lateral region of the first body-segment near its posterior border. The expanded part of the felted chamber which is antero-posteriorly flattened bears a number of radiating arms. Stigmata bearing 6, 8, 9, and 11 arms have been found, 8 being the usual number. In all cases examined, the two anterior stigmata of a single larva had the same number of arms. Each arm bears on its posterior face near its apex a minute longitudinal slit (*s.*). The lateral edges of the slit are curved so that the slit is narrowest in the middle, widens out slightly at its proximal end and considerably at its distal end. The proximal end of the slit is produced upwards into a minute triangular flap, and its distal end is produced downwards into a similar but more prominent flap, the two flaps largely filling up the widened ends of the slit. The whole felted chamber with its branches is enclosed in a delicate, chitinous sheathing-membrane (*s.m.*). This membrane appears to be absent from the extreme apices of the branches and does not, presumably, cover over the openings. These two points could not, however, be settled definitely.

The Posterior Spiracles (text-figs. 7 & 8) are situated at the apices of two very small stigmatic papillæ carried postero-dorsally by the last body-segment. Each papilla bears at its apex a rounded stigmatic plate (*s.p.*) in which are the three stigmatic openings. The posterior stigmata are of the same general type as the anterior ones. A bulb, which is, however, of no greater

Text-figure 6.

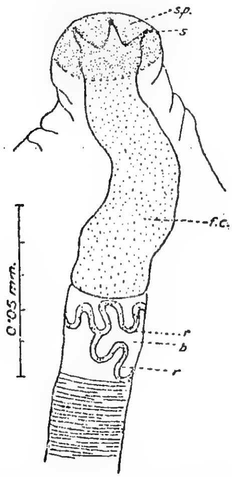


Posterior view of anterior spiracle.

diameter than the tracheal trunk, is interposed between the felted chamber and the tracheal trunk. Its wall is strengthened by two sinuous ridges which may be separate from each other, or the proximal one may be incomplete with its ends fused with the distal ridge as shown in text-fig. 7. I have not as yet seen a case where the distal ridge was incomplete. The felted chamber is relatively narrow and long, with its walls produced internally into delicate ridges and hairs; distally it divides into three very short branches (not, however, all in one plane as are those of the anterior stigmata), each of which opens on the stigmatic plate by one of the openings mentioned above. In an apical view of the stigmatic plate (text-fig. 8) a central dark area is seen caused by looking through the plate into the conical space between the three short arms of the felted chamber. In neither anterior nor posterior stigmata have I been able to distinguish any Stigmatic Scar. According to De Meijere, the visibility of this structure varies greatly in different species. It is, however, probably present in all third instar Cyclorrhaphous larvæ.

On each side of the body there is a dorso-lateral main tracheal trunk uniting the anterior and posterior stigmata of its side (text-fig. 9, *l.t.*). Uniting the two dorsal trunks are a series of ten dorsal commissures, the second of which is rather strongly looped forwards, the remainder being practically transverse. The first and tenth commissures, particularly the latter, are thicker than the intervening ones; the first gives off from each end an anteriorly directed branch which goes to the pharyngeal mass;

Text-figure 7.

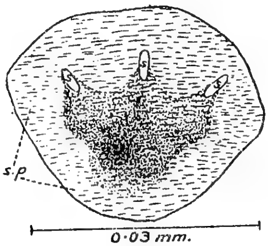


Dorsal view of posterior spiracle. (The stigmatic plate is seen by transparence.)

the remainder are quite devoid of branches. The middle point of each commissure shows a small rounded thickening which sections show to be attached to the dorsal body-wall by a slender suspensory ligament. The distribution of the dorsal commissures is as follows:—No. 1, anterior region of body-segment 3. No. 2 middle of segment 3, but looping strongly forwards. No. 3, anterior region of segment 4 (*i. e.* first abdominal). No. 4 arises at about the junction of segments 4 and 5, and nos. 5–10 arise similarly at the points of junction of the other body-segments. There is no transverse commissure at the point of junction of segments 11 and 12.

Each dorso-lateral trunk gives off eleven lateral trunks, the anterior three of which are small and are mainly distributed to the pharyngeal mass and its associated muscles, forming in this region a complicated plexus. The remaining eight lateral trunks pass down the lateral body-wall and bifurcate into anterior and posterior branches, by the joining up of which branches (text-fig. 9) a continuous but undulating ventro-lateral trunk is formed, from which branches are given off to the ventral body-wall and a few small ones to the lateral body-wall. The ventral body-wall branches of one side do not appear to anastomose with those of the other side.

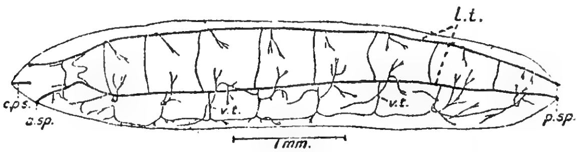
Text-figure 8.



Apical view of posterior spiracle.

Each of the eight posterior lateral trunks except the second and the last gives off two large branches, an anteriorly distributed and a posteriorly distributed; the latter may arise from the anterior side of the trunk; the second and last lateral trunks have no anterior branch, and the last has three posterior branches. The anterior branches of the lateral trunks are deep lying; they

Text-figure 9.

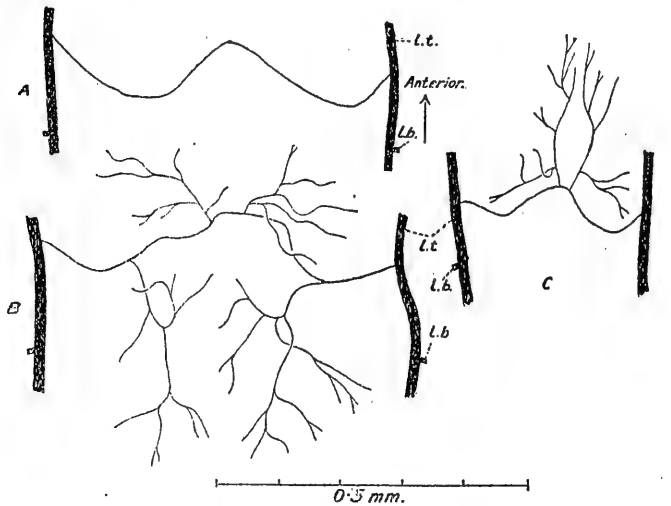


Dorso-lateral view of larva to show tracheal system.

supply the viscera and then run forwards, approaching the median ventral line, and supply a large ventral tracheal plexus in the region of the ganglionic complex. The posterior branches divide into two parts, one supplying the lateral body-wall, the other passing dorsally superficial to the dorso-lateral trunk to supply the dorsal body-wall. *The tracheation of the dorsal body-wall is supplied exclusively by branches from the lateral trunks, the dorsal commissures supplying no branches* (text-fig. 10 A).

The first three (small) anterior tracheal trunks are joined to the corresponding trunks of the opposite side by three very delicate ventral commissures which do not unite the trunks themselves but corresponding branches. No other ventral commissures could be discovered. The second tracheal trunk on each side gives off a backwardly-directed branch; these two branches converge to the dorsal surface of the brain, where they are joined by a short transvere commissure. From here they continue backwards, one on each side of the dorsal lobes, and pass downwards one on each side of the œsophagus, probably ending in the ventral tracheal plexus.

Text-figure 10.



Dorsal commissures and their tracheal branches in A. *Chlorops tæniopus*, B. *Balioptera combinata*, and C. *Meromyza nigriventris*.

All the lateral trunks except the first two bear a small appendage (*v.t.*) appearing as a very short tracheal branch. An attempt to investigate the nature of these by means of sections was not completely successful, but indicated that they were solid strands directed towards the lateral body-wall and in all probability attached to the latter. They are probably vestigial stigmatic trunks such as have been recorded by Imms (8) in the larva of *Anopheles*, and by Carpenter and Pollard (2) in the larva of *Hypoderma*.

Peristigmatic Glands.

Lying at the base of each posterior stigmatic papilla just ventral to the tracheal trunk and close to the hypoderm, is a group of two or three somewhat flask-shaped cells. A duct leaves each cell, and the three ducts join forming a common duct which passes backwards towards the stigmatic plate, upon which it probably opens, though it could not be traced to any opening. The gland cells are probably modified hypoderm cells. Keilin has described the peristigmatic glands in several Cyclorrhaphous larvæ.

The anterior stigmatic trunks are surrounded as they traverse the hypoderm by modified hypoderm cells which are probably of the nature of peristigmatic glands, although they are not nearly such prominent structures as the posterior peristigmatic glands and are apparently unprovided with ducts.

The Alimentary Canal and its appendages.

The structure of the pharynx has been described in connection with the pharyngeal sclerites. The hypoderm surrounding the ventral posterior arm of the pharyngeal sclerite is directly continuous posteriorly with the epithelium of the œsophagus, which is a straight, narrow tube with a very small lumen. In the first abdominal segment it traverses the ganglionic mass, slightly posterior to which it enters the cardiac valve (proventriculus). This is of the type commonly found in Dipterous larvæ. It is a pear-shaped body, its broad anterior end being continuous with the œsophagus, its narrow posterior end with the cardiac division of the midgut. The structure of the proventriculus is essentially similar to the house-fly larva (see Hewitt, p. 137) and will not therefore be described. The cardiac ring of imaginal cells occupies the same position as it does in the larva of the house-fly and other Dipterous larvæ.

The proventriculus lies in the anterior region of segment 5 (2nd abdominal). From here the midgut runs backwards to the anterior region of segment 10; turns dorsally and runs forwards to the posterior region of segment 4; backwards to segment 6, where its diameter decreases considerably; forwards to the posterior region of segment 5; backwards, its diameter increasing somewhat, to the middle of segment 10; forwards as a wide, thin-walled tube with a very poorly developed epithelium to the posterior region of segment 7, where it passes into the hindgut. This last section of the gut is liable to become enormously distended, when its epithelium becomes extraordinarily thin and ill defined; its contents are usually of a dark brown colour.

No attempt has yet been made to work out the detailed histology of the different regions of the midgut. As mentioned above, its last section was, in all examples studied, considerably distended; other regions of the midgut are also liable to distension, particularly the regions of the bends, and the appearance of sections of the gut-wall varies very greatly according to the degree of distension, great distension being frequently accompanied by partial degeneration of the epithelium of the affected region. The possession of a striated border is a constant characteristic of the cells of all regions of the midgut epithelium, and this border can usually be made out by careful examination even where the gut is very greatly distended. There is no peritrophic membrane in the midgut. From its point of junction with the midgut, the hindgut passes forwards for a short distance near to the dorsal body-wall and then turns backwards and runs as a practically straight tube to the anus. At its commencement the hindgut is slightly swollen and bulbous; on this follows the narrow anteriorly-directed region. The posteriorly-directed region is dilated until a short distance in front of the anus, where it again becomes a narrow tube. The whole of the hindgut is lined with a well-marked chitinous intima, which is thrown into numerous longitudinal folds, some of which are very prominent. There is a well-defined ring of imaginal cells at the junction of the mid-gut and hindgut.

Salivary Glands.

The salivary glands are two simple tubular bodies with a continuous central intercellular lumen. The glandular portion (as distinct from the duct) begins at the level of the proventriculus and passes backwards to about the posterior limit of the ninth body-segment, the glands lying one on either side of the gut. In about the sixth or seventh body-segment each gland turns dorsally, then forwards for a short distance, then again dorsally, and then backwards and ventrally to its termination near the ventral body-wall. These bends are always present, but their position is not absolutely constant. In transverse section the gland is circular, with a central star-shaped lumen surrounded by four to six gland cells. At the anterior end of each gland there is a narrow ring of small imaginal cells surrounding a small central lumen which is continuous posteriorly with the lumen of the gland and anteriorly with that of the salivary duct.

The duct is a narrow tube lined by a chitinous intima, its walls being formed of flattened cells, of which three are usually seen in any transverse section except anteriorly, where there are only two. Each duct runs forwards, becoming very closely applied to the ganglionic mass, and lying in the groove dividing the sub-œsophageal from the supraœsophageal ganglion. Anterior to the ganglionic mass the two ducts lie ventro-lateral to the œsophagus and directly ventral to the lateral edges of the antennal imaginal discs. As they pass forwards they approach the median line finally joining, slightly posterior to the pharyngeal mass, to form a single median duct which opens through the ventral wall of the pharynx at the point marked X in text-fig. 3. The duct narrows considerably just before entering the pharynx.

Malpighian Tubes.

There are two pairs of malpighian tubes, an anterior and a posterior. The anterior pair unite to form a short common tube which narrows considerably as it passes mesially to open into the left side of the gut at the point of junction of midgut and hind-gut. The posterior pair of tubes forms a similar short common tube opening in a corresponding position on the right side of the gut. From their point of junction the posterior tubes pass backwards in the dorsal region of the body, having a somewhat wavy course but no convolutions or sharp bends. The anterior tubes are almost twice the length of the posterior ones; from their point of junction they pass forwards in the dorsal region of the body to about the level of the proventriculus. They then turn abruptly posteriorly. The distal limb of each tube lies lateral to the proximal one, and has a somewhat greater diameter. The distal limbs extend backwards to a point slightly posterior to the point of origin of the malpighian tubes from the gut.

The proximal limbs of the anterior tubes are transparent and appear dark by reflected light; their lumen is very narrow. The distal limbs are opaque, glistening white by reflected light, and have a relatively wide lumen which contains a frothy mass. At present no more precise details can be given concerning this difference in structure, and presumably function, of the two regions of the anterior malpighian tubes, but it is hoped shortly to investigate the matter more fully. All that can be said at present is that the frothy mass in the distal limbs of the anterior tubes does not appear to consist of $CaCO_3$ which does occur in the malpighian tubes of certain Cyclorrhaphous larvæ (**11**). The posterior tubes resemble in structure the proximal limbs of the anterior tubes. The lumen of the malpighian tubes is in all places intracellular.

Central Nervous System—Cephalic Imaginal Discs and related parts (text-fig. 11).

The cerebral ganglia are rounded lobes lying in the first abdominal segment. They are separated from each other by a longitudinal dorsal fissure, except in their antero-ventral regions, where they are united by a short, and moderately thick, transverse commissure. Each is united by a broad œsophageal commissure to the ganglionic mass lying below the œsophagus. This ganglionic mass (called hereafter the subœsophageal ganglion) is a more or less cone-shaped body; it lies mainly in the first abdominal segment, but its posterior end extends a short distance into the second abdominal segment. It represents the fusion of the subœsophageal, thoracic, and abdominal ganglia of less specialised insects.

The œsophagus passes backwards from the pharynx along the dorsal surface of the subœsophageal ganglion. For part of its course it lies at the base of the fissure separating the dorsal lobes of the brain, and the transverse commissure (*t.c.*) uniting the two lobes lies immediately dorsal to it. The dorsal vessel (*d.v.*) dips down from the dorsal body-wall and passes through the dorsal region of the fissure separating the dorsal lobes of the brain. Between the posterior ends of the dorsal lobes it is surrounded by Weismann's Ring (*w.r.*), an oblique cellular collar, of which the dorsal part is anterior, the ventral part posterior. The ring is relatively thick at the sides but less so dorsally, where is produced laterally on each side into a fairly stout suspensory process (*s.pr.*) whose other end is attached to the surface of the dorsal lobe of its side. These suspensory processes do not appear to contain any nervous elements. The dorsal and lateral regions of the ring are formed of fairly large cells, each with a single large nucleus containing a big, densely-staining nucleolus and a few scattered chromatin granules. The ventral and posterior part of the ring is composed of very small cells which have exactly the appearance of the cortical ganglionic cells. This region is undoubtedly a ganglion; it becomes more prominent in mature larvæ, in which it is marked off from the lateral regions of the ring by a deep fissure on each side. A strand of tissue (presumably nervous) (*p.n.*) leaves this ganglion and passes backwards and downwards to the dorsal surface of the proventriculus where it forms a small ganglion (*p.g.*). Another strand (*m.n.*) goes forward and downward from the ganglion and passes under the transverse commissure uniting the dorsal lobes of the brain, in front of which it breaks up into four nerves which pass forwards to supply the œsophagus and pharyngeal mass. In the blow-fly larva, according to Lowne (**13**), the corresponding nerve swells out to form a small median ganglion just posterior to the transverse commissure, and from this ganglion nerves pass forward along the œsophagus, round which they form a plexus. The median ganglion could not be distinguished in *Chlorops*. From the posterior region of the transverse commissure a stout vertical strand of a fibrous nature (*v.s.*) passes upwards to be inserted into the ventral wall of the dorsal vesssel. There is no ganglion at its point of junction with the dorsal vessel and it gives off no nerves; it is probably, therefore, purely suspensory in function. The dorsal vessel passes forwards and, slightly anterior to the transverse commissure, it fuses with the posterior region of the cephalo-pharyngeal band in the manner described below.

The dorsal cornua of the pharyngeal sclerite are each surrounded by hypoderm, the hypodermal sheaths being united by a narrow arched band of hypoderm, which is continuous anteriorly with the hypodermal sheet which unites the dorsal margins of the pharyngeal sclerite and which, as mentioned in the description of the pharyngeal skeleton, is really a double sheet. The hypodermal sheaths of the dorsal cornua are continued posteriorly beyond the termination of the pharyngeal sclerite as hollow tubes of hypoderm (*i.s.p.*) united by the arched dorsal hypodermal plate (*c.p.b.*). The hollow tubes are the peduncles of the cephalic imaginal sacs and the arched plate is the cephalo-pharyngeal band. The relationships of the parts are most easily made out in fairly young third instar larvæ: in mature larvæ the enormous growth of the cephalic imaginal discs makes the interpretation of sections somewhat more difficult. In such a young larva the peduncles of the sacs decrease rapidly in diameter as they pass backwards and their cavity becomes practically obliterated. In the third thoracic segment they increase in size to form the cephalic imaginal sacs which contain the imaginal discs and a well-marked though narrow cavity. The cephalo-pharyngeal band extends outwards under the median region of their ventral surface, and its lateral margins are then produced downwards to form a lateral flap (*l.f.*) on each side. Slightly more posteriorly the imaginal sacs separate completely from the cephalo-pharyngeal band, their posterior ends being attached to the dorsal lobes of the brain by nervous tracts.

The lateral flaps are not deep anteriorly, but as they pass posteriorly their depth increases so that they hang down close against the sides of the œsophagus, their ventral edges lying slightly below the level of the ventral surface of the œsophagus, and being attached to two small longitudinal tracheæ which will be mentioned later. There is thus a well-defined sinus whose floor is formed by the œsophagus, and whose roof and sides are formed by the cephalo-pharyngeal band and its lateral flaps respectively. At about the anterior limit of the brain the dorsal vessel passes into this supraœsophageal sinus, its dorsal and lateral walls fusing with the cephalo-pharyngeal band. The vessel ends by opening into the sinus at the point marked Y in text-fig. 11. Slightly posterior to the opening of the vessel into the sinus the dorsal regions of the lateral flaps approach one another below the vessel and fuse, forming a vertical median plate (*m.pl.*). The vertical plate is short in the antero-posterior direction, and posterior to its termination the ventral parts of the flaps form an arched membrane over the œsophagus. As it passes backwards this membrane becomes less and less extensive and more and more closely applied to the œsophagus, and where the latter passes beneath the transverse commissure its dorsal and lateral regions are closely surrounded by the membrane, the ventral edges of which are united to the membrane covering the dorsal surface of the subœsophageal ganglion and to the two small longitudinal tracheæ already mentioned. The ventral parts of the lateral flaps do not extend posteriorly beyond the transverse commissure.

The two small longitudinal tracheæ mentioned above arise in the head region and pass backwards, one on each side of the œsophagus, until they come into relation with the ventral edges of the lateral flaps along which they pass to the dorsal surface of the subœsophageal ganglion.

As the larva approaches maturity the cephalic imaginal sacs and their contained discs increase enormously in size. The two sacs extend upwards above the cephalo-pharyngeal band until they are in contact along the median line; probably in a very late stage the two sacs communicate with each other as is the case in *Melophagus ovinus* (15), but this stage has not been observed. Each sac when almost fully developed consists of an antero-ventral region containing the antennal disc and a postero-dorsal region which contains the eye rudiment and also the rudiments of certain regions of the head capsule. The eye rudiment is innervated from the posterior region of the corresponding dorsal lobe; the antennal rudiment is, I believe, innervated from the anterior region of the dorsal lobe, but I have not been able to establish this quite definitely. The ocular half of the imaginal sac overlies the anterior half of the corresponding dorsal lobe.

The process of evagination of the cephalic discs is believed to be as follows:—The right and left sacs fuse in the median line above the cephalo-pharyngeal band so that their cavities communicate. This fusion gradually extends forwards to include the peduncles whose central cavities come to form merely the lateral regions of the peripodal cavity of the conjoined sacs. When this fusion extends as far forwards as the point of origin of the peduncles from the pharyngeal part of the cephalo-pharyngeal band, which as mentioned above appears to be a

Text-figure 11.

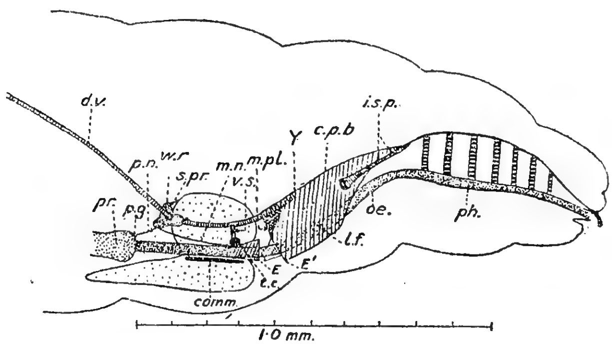


Diagram to show relations of cephalo-pharyngeal band, dorsal vessel, and related structures. The right dorsal lobe of the brain, and the right cephalic imaginal sac are represented as having been removed; left cephalic imaginal sac and its peduncle not shown. Part of the cephalo-pharyngeal band between the points E and E¹ is represented as having been removed. (Reconstructed from serial sections and dissections.)

double layered structure in this region, the two layers of the band become more definite and split apart, the space between the two layers being continuous posteriorly with the cavity of the united imaginal sacs, and it is through this space that the imaginal discs evaginate. I have not seen this process but, as is mentioned below, the commencement of such a fusion of the sacs and their peduncles has been seen in connection with the prothoracic leg discs.

Thoracic Imaginal Discs.

On each side of the body there are three leg discs—prothoracic, mesothoracic, and metathoracic. From the antero-ventral region of the sub-œsophageal ganglion there arise on each side three stout nervous tracts one supplying each leg disc. Each imaginal leg sac is pear-shaped with its broad posterior end receiving the nerve from the ganglion, its narrow anterior end being produced forwards into the peduncle of the sac.

The prothoracic leg sacs and their contained imaginal discs lie in the median region of the third thoracic segment. In all specimens examined the peripodal cavities of the sacs communicated with each other, but this union would probably not be found if sufficiently young specimens were examined; it is quite certain that the prothoracic leg discs reach a given stage of development sooner than do the meso- and metathoracic leg discs. This point is referred to again below. The peduncle of each sac passes forwards close to the ventral body-wall to end in the ventral hypoderm of the prothoracic segment slightly to one side of the median line. At the point where the peduncle reaches the hypoderm the chitin of the body-wall is traversed by a minute fissure elongated transversely to the longitudinal axis of the body. The fissure in the chitin is, of course, due to the discontinuity of the hypoderm over a small area brought about by its invagination to form the peduncle of the sac. The fissure passes obliquely through the chitin, so that in a longitudinal section through the peduncle and fissure the two form a practically continuous line. I am unable to offer any explanation of the obliquity of the fissure. Similar fissures occur opposite the peduncles of the other leg discs and opposite those of the wing and haltere discs.

One specimen which, when killed, was approaching its time of pupation, showed the method of evagination of the prothoracic legs. The united imaginal sacs had grown forwards between the peduncles of the sacs so that the inner two-thirds of the peduncles were united by two closely approximated horizontal hypodermal sheets, a dorsal and a ventral, the space between the two sheets being continuous posteriorly with the cavity of the united imaginal sacs. The central cavities of the inner two-thirds of the peduncles had not remained separate, but were probably represented by the extreme lateral regions of the space between the dorsal and ventral hypodermal sheets. There can be little doubt that eventually the whole length of the peduncles becomes united by the dorsal and ventral hypodermal sheets; thus, eventually, there is only one imaginal sac with a single broad, dorso-ventrally flattened, peduncle, and containing the two prothoracic leg discs. Probably, when evagination is to take place, the dorsal and ventral walls of this flattened peduncle separate, and the sac evaginates through the space between them. In the specimen from which the above particulars were obtained the meso- and metathoracic imaginal leg sacs showed no sign of union, though they almost certainly undergo the same process at a later stage. In all larvæ examined the degree of development was greatest for the prothoracic leg discs, less for the mesothoracic, and least for the metathoracic.

The mesothoracic leg discs lie slightly posterior and ventral to the prothoracic discs; their peduncles pass forwards to the ventral hypoderm of the mesothoracic segment. In the specimens studied the mesothoracic imaginal leg sacs did not communicate with one another, though they probably do so at a later stage.

The metathoracic leg discs are posterior to the mesothoracic and rather more lateral and dorsal. They are united to both the wing and haltere discs by strands of tissue accompanied by small tracheæ derived from the third lateral tracheal trunk. The figure given by Lowne (p. 84) of the wing, haltere, and metathoracic leg discs of the larva of *Calliphora* approximates very closely to the condition found in *Chlorops*.

In a fairly mature larva a small imaginal disc can be found arising just posterior to the anterior stigmatic trunk on each side at the point where this traverses the hypoderm. In the most advanced stage so far examined these discs are only shallow invaginations of imaginal cells and cannot be said to consist of peripodal cavity, peripodal membrane, and imaginal disc. They may, however, and probably do, increase in complexity towards the end of larval life.

The wing rudiments are the largest of all the imaginal discs; they lie mainly in the mesothoracic segment, but their posterior rounded ends extend into the anterior region of the metathorax. Each lies mainly dorsal and internal to the dorso-lateral tracheal trunk of its side, but anteriorly it narrows and passes dorsally over the trunk to the external side of the latter. Its narrow anterior end is produced into a short peduncle which passes to the dorso-lateral hypoderm in the posterior region of the mesothorax.

The haltere disc lies ventral and external to the dorso-lateral tracheal trunk, the bulb of the disc overlying the base of the third lateral tracheal branch. Its peduncle joins the hypoderm in the mid-lateral region of the metathorax.

The innervation of the spiracular, wing and haltere discs has not been followed out.

A minute trachea accompanies the peduncles of all the thoracic imaginal discs.

Imaginal Discs of the Mouth Parts.

There are two pairs of imaginal mouth rudiments. The larger pair, the maxillary discs, lie one on either side of the anterior region of the pharyngeal mass. They are broad posteriorly, but taper off anteriorly into peduncles which are attached to the head capsule just latero-dorsal to the mouth-opening. Posteriorly they appear to be united dorsally to the hypoderm overlying the pharynx, which is continuous posteriorly with the cephalo-pharyngeal band. They are united ventrally by a hypodermal sheet passing below the pharynx.

Below the anterior region of the pharynx there are two extremely small discs which appear to consist of solid longitudinal rods of embryonic cells lying close together near the median line. They are attached posteriorly to the hypodermal sheet uniting the maxillary discs below the pharynx: they are the labial discs. Their peduncles are attached anteriorly to the median ventral hypoderm of the head immediately posterior to the mouth-opening and some little distance anterior to the opening of the salivary duct in the pharynx.

I have found no mandibular imaginal discs. These are also absent in the Blow-Fly (**13**) and the House-Fly (**4**). According to Lowne (p. 83) Kunckel d'Herculais described and figured mandibular discs in the resting larva of *Volucella*, but I have been unable to find either the figure or the statement in Kunckel d'Herculais' work (**12**).

Imaginal Discs of the External Genitalia.

Immediately in front of the anus there are two imaginal sacs lying against the ventral hypoderm in the median line, each sac containing two imaginal discs, one on each side in its anterior region. The posterior sac is the larger; it has a very short, transversely broad peduncle, which opens out anteriorly into a small imaginal sac, in whose antero-lateral regions lie the two discs. The anterior imaginal sac is similar to, but rather smaller than, the posterior. Both sacs lie in the mid-ventral region of the eleventh body-segment (8th abdominal). The posterior disc develops before the anterior one, being well formed when the latter is a mere hypodermal thickening. It is possible that differences exist in the formation of these discs in ♂ and ♀ larva, which would enable one to detect the sex of a larva, but such differences have not yet been observed.

From the examination of two specimens in which the anterior disc was in the form of a hypodermal thickening, I am inclined to believe that the paired discs are from the commencement of their formation enclosed in a single common imaginal sac, and that this single sac with its single peduncle is not formed by the fusion during later stages of larval life of two originally separate discs. The evidence on this point, however, is by no means conclusive.

Imaginal Discs of the Abdominal Segments.

In the most mature larva examined the abdominal discs were in the form of two small lenticular thickenings in the dorso-lateral hypodermis on each side about the middle of each segment. The cells of these discs originate by the amitotic division of an ordinary hypoderm cell; the nuclear membrane disappears, and the nucleoplasm splits up into numerous little masses each of which becomes the nucleus of an imaginal cell. It is possible that the same process goes on in other regions of the hypodermis at a later stage, but it has only been actually observed in the dorso-lateral regions. The abdominal imaginal discs, of course, never become invaginated, and therefore have no imaginal sac and no peduncle.

The Dorsal Vessel.

The dorsal vessel is a tubular organ lying close beneath the dorsal hypoderm in the median line, its posterior end lying at about the junction of segments 10 and 11. From here it runs forwards as far as the anterior region of segment 6, where it dips ventrally to the brain to take the course already described in connection with the central nervous system, etc. The part of the tube lying in segment 10 is relatively wide, but it narrows considerably as it passes forwards into segment 9. The wide posterior region may be defined as the heart; the portion anterior to segment 6 may be termed the aorta. The ostia are confined to the cardiac region, but I have been unable to make certain as to their number and position. The posterior end of the heart is slightly anterior to the posterior transverse commissure. The latter is suspended from the dorsal integument by a delicate double transverse membrane, the space between the two layers being wide dorsally but narrowing ventrally where the membrane fuses with the commissure. From the middle of the anterior membrane a delicate ligament passes forwards to become attached to the ventral wall of the posterior end of the dorsal vessel. At about the level of each pair of pericardial cells (see below) in segments 10–6 inclusive the dorsal vessel is attached to the dorsal hypoderm by a delicate ligamentous strand.

Pericardial Nephrocytes, and Alar Muscles.

On each side of the dorsal vessel there are 26 pericardial cells (nephrocytes) situated as follows:—

In each of segments 10, 9, and 8, four cells on each side.

In segments 7 and 6, five cells on each side.

In segment 5, four cells on each side.

The cells lie in pairs, one on each side of the vessel, exactly opposite each other. Seen in surface view in the living larva the cells are perfectly circular; in transverse or longitudinal section they are oval. They are all uninuclear. In the majority of cyclorrhaphous larvæ the pericardial nephrocytes are of two kinds; posteriorly there are a few large cells somewhat separated from each other, while anteriorly the cells, though similar to the posterior ones in structure, are smaller, more numerous, and closely crowded (see Keilin, 1917, for a review of the subject). In *Chlorops*, however, there is no such distinction, the cells being all alike.

In connection with each pericardial cell (with the exception of the four anterior pairs which lie alongside the ventrally-directed portion of the vessel) there is an alary muscle. The alary muscles of any segment arise close together from the mid-lateral region of that segment, slightly ventro-lateral to the dorso-lateral tracheal trunk. Each arises by a short dorsal and a short ventral root, which unite to form a very thin strap-like muscle which passes inwards and dorsally below the dorso-lateral tracheal trunk to the pericardial cell to which it is related. Here it splits into dorsal and ventral layers which are inserted respectively into the dorsal and ventral walls of the dorsal vessel, and between which lies the pericardial cell. The dorsal and ventral layers do not retain their narrow strap-like form but spread out fanwise in the antero-posterior direction, so that the anterior ends of their insertions into the heart extend as far forwards as the posterior ends of the insertions of the alar muscles next in front of them. The figures given by Imms (**8**, figs. 9 & 10, Pl. ix.) show the arrangement of the alar muscles in relation to the dorsal vessel in *Anopheles*, and the arrangement in *Chlorops* is almost identical.

Ventral Nephrocytes.

In Muscid larvæ the ventral nephrocytes usually form a transverse loop of cells passing below the gut, each end of the loop being attached to one of the salivary glands at the junction of the glandular region and duct. In *Chlorops*, however, the ventral nephrocytes consist of two separate masses each of seven or eight cells, the groups lying one at the anterior end of each salivary gland between the gland and the proventriculus and attached to the gland at the region of junction of the duct with the glandular portion. These cells are very much smaller than the dorsal nephrocytes and are binucleate; they also differ from the dorsal nephrocytes in several cytological details which will not, however, be considered here.

Œnocytes occur in each of abdominal segments 1 to 7 inclusive, as two groups of about five or six cells, the groups lying one on each side of the segment close against the hypoderm in the mid-lateral region. The cells are all uninucleate with rather dense, finely granular, and nonvacuolated protoplasm.

Small Genocytes (**8**) appear to be absent.

The Fat Body consists of lobes and chains of large cells lying between the various organs of the body. There is no fat body in the head and very little in the thoracic segments.

Integument.

The chitin consists of two layers, an outer thin and dark coloured, and an inner thick and light coloured. The surfaces of the two layers where they come in contact are very minutely serrated, the serrations engaging with each other. The horizontal split by which the puparium will open is marked out in the third instar larva by what is apparently a closed fissure, appearing in sections as a thin dark line through the chitin, which passes horizontally round the anterior end of the larva and back on each side to the posterior region of the metathoracic segment. The peduncles of the wing discs reach the hypoderm at a point immediately opposite this fissure. The vertical splits which pass up and down the lateral regions of the puparium from the posterior ends of the lateral splits do not appear to be similarly marked out in the third instar larva.

Gonadial Rudiments.

The rudiments of the ovaries or testes lie one on either side of the fifth abdominal segment in its posterior region. They are solid oval masses of cells with the long axis parallel to the long axis of the body, and are attached to the neighbouring fat body. As I have not so far been able to distinguish a larval ovary from a larval testis, it would be quite useless to give any account of the structure of the gonadial rudiments.

Muscular System.

The details of the muscular system have not been worked out. The arrangement of the muscles probably approximates very closely to their arrangement in *Musca domestica* which is described by Hewitt (4).

C. *Other Immature Stages of* Chlorops.

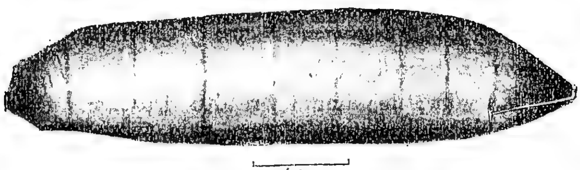
The Puparium (text-fig. 12).

Length 5·4 mm.; maximum breadth 1·5 mm. Colour extremely variable; all shades between pale yellow to very dark brown. Thoracic segments slightly dorso-ventrally compressed, much wrinkled transversely and obliquely, always darker coloured than the abdominal segments; apices of wrinkles usually appearing dark brown or black, the spaces in between being lighter. The last two abdominal segments are also considerably wrinkled and darker coloured than the others. The other abdominal segments are also transversely wrinkled, but the wrinkles are not pronounced or close together and are not darkened. The larval cephalo-pharyngeal skeleton lies pressed against the ventral wall in the anterior end of the puparium. The larval head is completely withdrawn within the prothorax and is quite invisible. The larval stigmata stand out clearly. There are no pupal dorsal respiratory trumpets projecting through the dorsal wall of the puparium (*cf.* Keilin, 1917).

For the exit of the imagines the anterior end of the puparium splits into dorsal and ventral halves by means of a horizontal split running round its anterior end and backwards along each side as far as the anterior region of the first abdominal segment. From each posterior end of this split a dorsal and a ventral split extends round the anterior end of the first abdominal segment. The extent of these transverse splits is very variable; sometimes they are very short, sometimes the dorsal ones meet in the middorsal line and the ventral ones in the mid-ventral line, so that when the imago emerges the whole of the thoracic region of the puparium falls off in two halves. Usually the ventral splits are longer than the dorsal. When the puparium splits the larval spiracles are situated on the dorsal half of the split thorax, very slightly dorsal to the split.

The First Larval Instar is extremely similar to the third instar. The head and cephalo-pharyngeal skeleton are identical in form to those of the third instar; the arrangement of the tracheal trunks is the same, but the smaller branches of the tracheal system ramify less extensively, many being either not yet formed or not filled with gases so as to be visible. On emergence from the egg the larva is completely apneustic. The dorso-lateral tracheal trunks extend from the anterior region of the second body-segment to the posterior region of the eleventh body-segment. There is no indication whatever of anterior spiracles. Posteriorly, in the position occupied in the second and third instars by the posterior stigmatic papillæ, there are two stout and prominent papillæ with a truncated apex. These show no trace of stigmatic openings, and the dorso-lateral tracheal trunks do not extend into them; four rather stout pointed setæ radiate outwards from the dorso-lateral border of the apex of each of these papillæ.

Text-figure 12.



C. tæniopus. Lateral view of empty puparium.

In the first larval instar there is no difference in shape between the thoracic and abdominal denticles, all being of the approximately semicircular shape found on the abdominal segments of the third instar. Their distribution is slightly different from that in the third instar in that they do not appear to extend into the dorsum of the thoracic segments. Such characters as these, however, require very careful examination with an oil immersion. I have not yet succeeded in finding the vestigial leg-sense organs in the first instar; if they are present, however, they will naturally be extremely minute, and I am not, therefore, prepared to say definitely that they are absent.

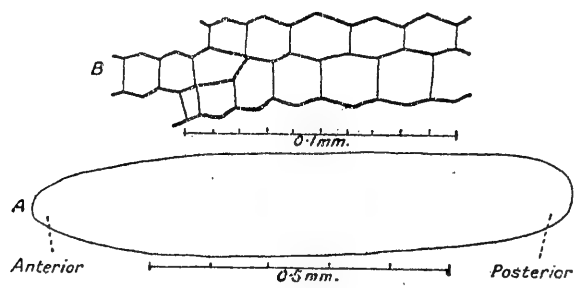
$\dfrac{\text{Maximum length of cephalo-pharyngeal sclerites}}{\text{Maximum dorso-ventral depth of sclerites}} = 3\frac{1}{2}$ in the third larval instar and about $4\frac{1}{2}$ in the first larval instar.

With the exception of the above points the first instar is a miniature replica of the third.

The Second Larval Instar is identical in external anatomy, except for size, to the third. A mature second instar is only recognisable from a young third instar by the fact that in the former there can be seen the developing spiracles and cephalo-pharyngeal skeleton of the third instar alongside those of the second instar itself.

The Egg (text-fig. 13) is approximately cylindrical with its ventral surface flattened and its dorsal surface strongly convex transversely and slightly so longitudinally. The egg narrows slightly at both ends. There is a definite polarity of the eggs which are always laid on the leaf of the host-plant in a certain way. The anterior end, which points towards the apex of the leaf, is slightly dorso-ventrally flattened and very slightly truncate at the apex. The posterior end is evenly rounded and not dorso-

Text-figure 13.



C. tæniopus. A. Outline drawing of egg viewed dorsally.
B. Outline of pits on dorsal surface seen at a higher magnification.

ventrally flattened. The upper surface and sides of the egg are ornamented with small polygonal depressions set in longitudinal rows, which may or may not extend the whole length of the egg. The ridges separating two adjacent depressions in a row are not quite so high as the longitudinal ridges which separate adjacent rows. The ventral surface of the egg bears a few longitudinal rounded ridges. The egg is firmly attached to the plant upon which it is laid by a transparent cementing material. No micropylar apparatus has been observed.

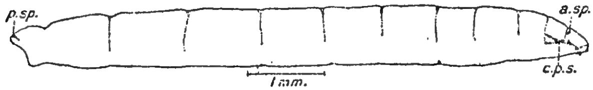
Host-Plants.

As the question of the host-plants of *Chlorops* will be considered in detail in a later paper, it will be sufficient to state here that *Agropyrum* (= *Triticum*) *repens* is the only wild grass in which the larva has been found up to the present.

Meromyza nigriventris Mcq.

The full-grown larva (text-fig. 14) is about the same length as that of *Chlorops*, but is rather more slender. It is almost always a bright green colour, but occasionally almost colourless specimens are found. Other prominent characteristics are the sessile

Text-figure 14.

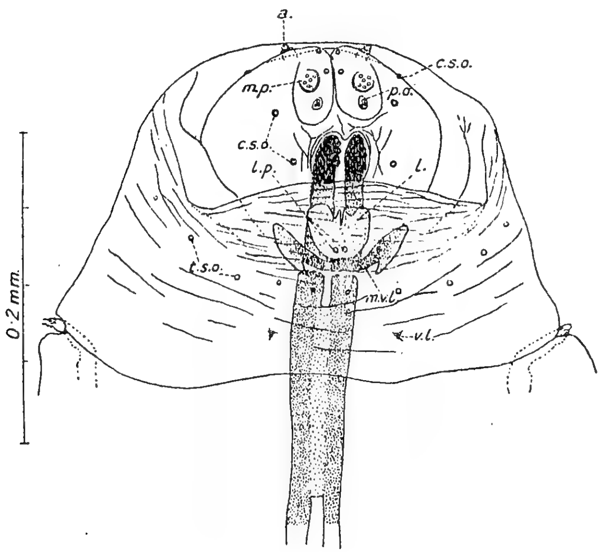


M. nigriventris. Lateral view of mature larva.

posterior stigmata, the presence in the cephalo-pharyngeal skeleton of a median ventral piece, and the peculiar shape of the last abdominal segment when seen laterally.

The Head (text-fig. 15) differs in several points from that of *Chlorops.* The antennæ are anterior instead of lateral. The

Text-figure 15.



M. nigriventris. Ventral view of larval head.

maxillary palps are situated on two prominent swellings separated by a rather deep median fissure: the chitinous ring surrounding the maxillary palp sense organs is incomplete antero-laterally. The pre-oral sense organs are situated on the postero-ventral regions of the swellings bearing the maxillary palps; each is a roughly triangular plate bearing four small circular sense organs, a larger central one and an anterior and two posterior smaller ones. The labial plate bearing the two labial sense organs occupies the same position as in *Chlorops*, but differs somewhat in shape. The position of the small circular cephalic sense organs is shown in text-fig. 15. At each side of the oral aperture, running more or less parallel to its lateral margin, there are three chitinous ridges which extend from the antero-lateral region of the mouth-opening to its postero-lateral region.

Thoracic Segments.

Instead of rows of chitinous teeth such as occur on *Chlorops*, *Meromyza* has low transverse ridges of varying lengths, the apices of the ridges being minutely serrated. Almost the whole of the dorsal surface of the prothoracic segment bears these ridges, only a narrow posterior region being free from them. Ventrally the ridges extend across the whole breadth of the anterior margin, but passing posteriorly they become less and less extensive, so that they form a roughly triangular area, the base of the triangle lying across the anterior margin of the segment, the apex of the triangle lying in the median region of the segment a little anterior to its posterior margin.

The meso- and metathoracic segments have ridges all round their anterior borders, the ridges being numerous, closely placed, and covering broad areas in the middle of dorsal and ventral surfaces, but becoming much less numerous, wider apart, and confined to a narrower area laterally.

In the antero-ventral region of each thoracic segment is a transverse series of circular sense organs, five on each side of the median line. The vestigial rudiments of the legs are similar to those of *Chlorops*.

Abdominal Segments.

There are nine abdominal segments, the ninth being rather small with its posterior region capable of partial withdrawal into its anterior. The anus, which is situated ventrally on the anterior region of the ninth abdominal segment, is a narrow, longitudinal slit, bounded on each side by a fairly prominent oval swelling; there are no adjacent chitinous teeth or special sense organs. The last abdominal segment is divided posteriorly into two lobes by a deep and broad vertical fissure; the sessile posterior stigmata lie facing one another, one on each side of the fissure.

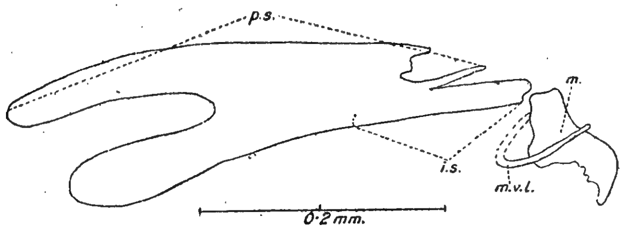
Chitinous ridges, similar to those on the thoracic segments, surround the anterior regions of each abdominal segment except the last. No ridges occur round the posterior border of any segment. There are no ambulatory swellings.

Circular sense organs, similar to those on the thoracic segments, occur in transverse rows of about ten on the ventral surface in the posterior half of each abdominal segment. There is a row behind the anus, and their presence makes it practically certain that what in this and the other larvæ described here (see *Chlorops* above) I have called the ninth abdominal segment really is a separate segment.

Cephalo-Pharyngeal Skeleton. (Text-fig. 16.)

This is of the same general type as that of *Chlorops*, and the differences of detail can be made out from the figures. The most striking difference is perhaps the presence of a median ventral

Text-figure 16.



M. nigriventris. Lateral view of cephalo-pharyngeal sclerites.

piece. This plate also occurs in *Balioptera combinata*, where its relations with the neighbouring parts are more easily made out (see below).

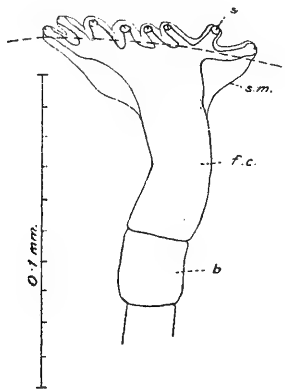
Tracheal System.

The anterior stigmata are of the usual branching type and are situated near the posterior margin of the first body-segment, slightly dorsal to the mid-lateral line. The branches are extremely short and project very little from the body-surface (text-fig. 17).

The posterior stigmata (text-fig. 18) are, as already mentioned, sessile and not at the apex of a stigmatic papilla; there is no stigmatic plate and each of the three openings projects very slightly above the body-surface. Four pairs of branching hairs arise, as shown in the figure.

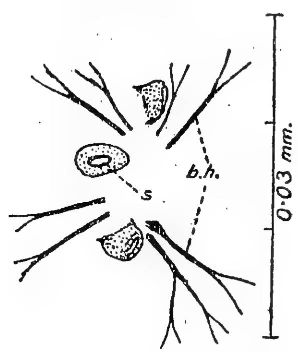
The arrangement of the tracheal trunks and branches is very similar to that found in *Chlorops*. There are many differences of detail which do not, however, merit the extended description necessary to make them clear: one difference only is noteworthy. In *Chlorops* the dorsal commissures give off no branches to the dorsal region of the body, which is supplied by branches from the lateral trunks. In *Meromyza* (text-fig. 10 C) each dorsal commissure, except the second and the last, gives off two anteriorly-directed branches, which ramify extensively to supply the dorsal tracheation of the segment in whose posterior region arises the dorsal commissure from which they take origin. Very little of the dorsal tracheation is supplied by branches from the lateral trunks.

Text-figure 17.



M. nigriventris. Anterior spiracle. The dotted line indicates the surface of the body.

Text-figure 18.



Posterior spiracle of *M. nigriventris.*

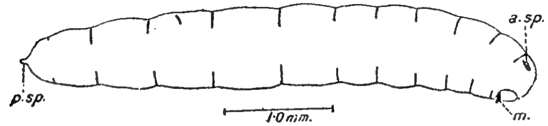
Puparium.

Length 5·7 mm. Maximum breadth 1·2 mm. Practically colourless, but appears green owing to colour of pupa within. Wrinkling as in *Chlorops*; wrinkles have a light golden-brown colour. Splitting of puparium as in *Chlorops* except that the vertical splits always meet dorsally and ventrally, so that the thoracic segments always separate off completely in dorsal and ventral halves (except that they may remain attached to the nymphal integument).

Balioptera combinata L.

The full-grown larva (text-fig. 19) is shorter and relatively thicker than that of *Chlorops*. Its cephalo-pharyngeal skeleton is proportionately larger than in any other larva considered here.

Text-figure 19.

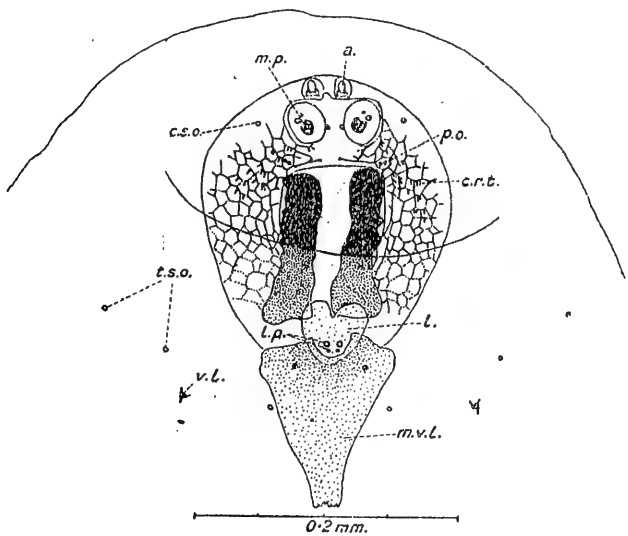


Balioptera combinata. Lateral view of mature larva.

Its most prominent characteristics are its large anterior stigmata and the heavily chitinized median ventral piece of its cephalo-pharyngeal skeleton.

The Head (text-fig. 20) is chiefly remarkable for the arrangement of the numerous chitinous ridges on its ventral surface,

Text-figure 20.



B. combinata. Ventral view of larval head. (The rows of chitinous denticles on the prothorax have been omitted.)

which is divided by them into small polygonal areas whose distribution is shown in the figure. Certain of the ridges in the region antero-lateral to the mouth-opening bear small chitinous teeth (*c. r. t.*) pointing posteriorly.

The maxillary palps are borne by two fairly prominent swellings; their circular sense organs are surrounded by chitinous rings which are incomplete antero-laterally, and two slightly larger circular sense organs lie just outside the gaps in the rings. The antennæ are only remarkable in that the apical joint is almost as broad as long, instead of being markedly longer than broad as in the other larvæ considered here. The pre-oral sense organs are inconspicuous, each consisting of two small circular sense organs situated close together but not carried on any special swelling; they are quite separate from the swellings which bear the maxillary palps. The labial plate is again characteristic in shape, so far as the larvæ considered in this paper are concerned, and is remarkable in bearing two pairs of labial sense organs, the anterior pair being the larger. The distribution of the small cephalic sense organs is shown in the figure, except for one pair which are not visible in a ventral view, as they are situated one on each side of the head slightly dorsal to the mid-ventral line and on a level with the anterior margin of the mouth-opening.

Thoracic Segments.

The chitinous denticles on the thoracic segments are considerably larger than those on *Chlorops*. They occur all round the anterior margins of the first and second thoracic segments as moderately broad bands. The third thoracic segment has no anterior teeth ventrally and only a few laterally and dorsally; a little in front of its posterior margin, however, it bears a single row of teeth extending across its ventral region and up most of its lateral regions. There are six thoracic sense organs on each segment forming a transverse row behind the region bearing the chitinous teeth. The vestigial leg rudiments are similar to those in *Chlorops*.

Abdominal Segments.

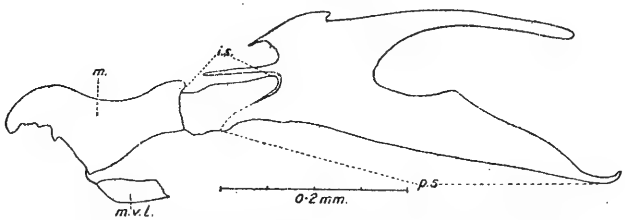
There are nine abdominal segments, the last bearing the anus ventrally and the posterior stigmatic papillæ posteriorly. The morphology of the last two body-segments is rather obscure, and this point is dealt with below. The arrangement of the chitinous teeth on abdominal segments 1 to 7 is practically identical. Each bears near its anterior and posterior margin a transverse band of chitinous teeth, which are from two to four rows broad ventrally, but become less numerous as they pass up the lateral regions of the segment. In the first four abdominal segments the teeth are continued over the dorsum as a single anterior and posterior row on each segment, but on the other segments they are not continued above the mid-lateral line. The posterior teeth on the seventh abdominal segment form only a single row ventrally. Ventrally there is a narrow space between the posterior rows of teeth of one segment and the anterior rows of the next segment behind it, and this space, which corresponds largely to the thin intersegmental membrane, is capable of a slight degree of protrusion to form a ventral pseudopod.

Behind the seventh abdominal segment there appears to be one large segment bearing the longitudinal slit-like anus in its mid-ventral region, and a very small postero-dorsal segment, consisting mainly of the two stigmatic papillæ and capable of partial withdrawal into the apparent segment in front of it. This, however, is not the true nature of this region. A study of the musculature shows that the large segment consists of two segments, abdominal segments 8 and 9, and the small posterior stigmata-bearing region is almost certainly to be regarded merely as a specialized region of segment 9. Some indication of the composite nature of the large segment is available without a study of the musculature. In front of the slit-like anus is a transverse row of about 17 sharp, posteriorly-directed, chitinous teeth, and behind it is a small patch of about seven similar teeth pointing forwards. It seems probable that the anterior row represents the posterior band of teeth of segment 8, and the posterior patch the anterior band of segment 9, the anus lying therefore between the two segments. The anus is not bounded by lateral swellings.

Cephalo-Pharyngeal Skeleton.

The form of this is sufficiently shown in text-fig. 21, and only two points require special mention, the ventral wall of the pharynx

Text-figure 21.



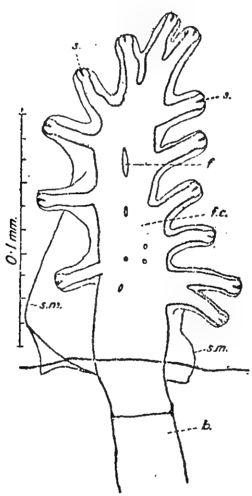
B. combinata. Lateral view of cephalo-pharyngeal sclerites.

and the median ventral piece. The ventral wall of the pharynx in the region of the pharyngeal sclerite has distinctly the appearance of being longitudinally ribbed when seen in surface view. As I have not examined sections of the larva, I can give no indication of the true nature of these ribs. The median ventral sclerite is a somewhat shield-shaped chitinous plate with its lateral margins bent strongly upwards. Its anterior margin shows a central curved emargination bounded on each side by a rather prominent process from which a cord, apparently of a tendinous nature, goes forward to the ventral process of the corresponding mandible. Posteriorly the plate becomes less heavily chitinized and appears to be serrate; into it are inserted the depressor muscles of the mandibles. The median ventral piece bears two rather prominent circular sense organs, one on each side of its anterior region.

Tracheal System.

The anterior spiracles (text-fig. 22) are borne dorso-laterally by the first thoracic segment in its posterior third and project forwards close to the surface of the segment. They are very prominent structures, consisting of a rather broad dorso-ventrally flattened central stem, bearing about 13 lateral branches. Along the median region of the central stem are a series of small fissures (*f.*), which apparently pass right through the stem, being only covered by the delicate membrane by which the whole structure, except the apices of the branches, is covered.

Text-figure 22.

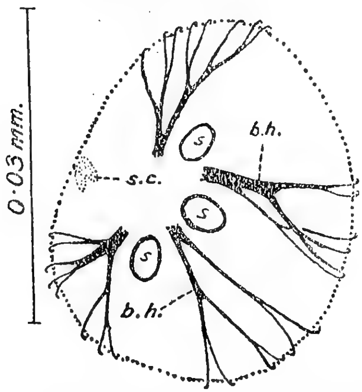


B. combinata. Anterior spiracle.

The posterior spiracles (text-fig. 23) are carried at the apices of two prominent posterior stigmatic papillæ. There is no definite chitinized stigmatic plate. The form of the stigmata and the branching hairs may be seen from the figure. The stigmatic scar (*s.c.*), which I have failed to find in *Chlorops* and *Meromyza*, is fairly prominent in *Balioptera*, but it does not occupy the position in which it is found (as the "Button") in most Muscid larvæ. It lies on the median side of the stigmatic papillæ some distance below the apex.

The distribution of the tracheæ is essentially similar to that in *Chlorops*, the chief difference being the branches given off from the ten dorsal commissures, the first and last of which are, as usual, thicker than the others. The tenth commissure gives off no branches; the first gives off at each end a moderately large anteriorly-directed branch; the second loops strongly forwards over the first and gives off a few branches anteriorly; the third is also strongly looped forwards and gives off a few branches anteriorly. Commissures 4 to 9 inclusive are similar and are represented in text-fig. 10 B. They are roughly transverse and give off branches both anteriorly and posteriorly, each commissure supplying the dorsal tracheation of the posterior half of one segment and the anterior half of another. The dorsal commissures themselves occupy approximately the same positions with regard to the body-segments as they do in *Chlorops*.

Text-figure 23.



B. combinata. Posterior spiracle. The dotted line represents the edge of the apex of the stigmatic papilla.

Puparium. Length 3·2 mm. Maximum breadth ·9 mm.

Colour golden brown; anterior and posterior ends much wrinkled and blackish. The thoracic segments are much flattened dorsally, so that their dorsal surface shows a large shallow concavity, from the antero-lateral corners of which the prominent anterior spiracles of the larva projects forwards.

For the emergence of the imago the puparium splits in the usual manner along the lateral regions of the thoracic segments, which in this case correspond to the lateral margins of the dorsal concavity. The posterior ends of the lateral splits are joined by a dorsal transverse split, and the whole of the dorsal region of the thoracic segments splits off as a roughly quadrangular plate, which may or may not become completely detached from the puparium. The anterior spiracles are attached to the dorsal plate.

Chloropisca glabra Meig.

This fly was bred out in considerable numbers from various grasses and has also been found infesting Winter Wheat and Barley. It was originally intended to describe here the larval form. The larva is, however, so extremely similar to that of *Oscinis frit* that it has been decided to defer the description of the *Chloropisca* until a detailed comparison of these two larvæ can be made. The only differences so far observed are the somewhat larger size of the *Chloropisca* larva and its rather more yellow colour; such differences are obviously unsatisfactory.

The chief winter host of *Chloropisca* is *Lolium perenne*.

Winter Host-Plants of *Chlorops tæniopus*, *Meromyza nigriventris*, and *Balioptera combinata*.

After a considerable amount of purely qualitative grass examination had been done, an attempt was made to reduce the work to a quantitative basis by bringing in samples of the various grasses, examining each shoot in the laboratory, and finding a percentage figure of infestation. The figures were, however, found to vary very greatly in samples of the grasses taken from different localities and are not, I think, worth giving. I consider that to obtain a reliable infestation figure for a grass in this way, at least 20,000 shoots would have to be counted, taken in samples of about 1000 shoots from different localities. This is obviously impossible when one is examining a considerable number of different grasses.

Chlorops tæniopus has only been found in *Agropyrum repens* among the wild grasses examined. *Meromyza nigriventris* occurs in *A. repens*, *Festuca ovina*, and *Alopecurus pratensis*; *Balioptera combinata* occurs in *A. repens*, *Festuca elatior*, *Lolium perenne*, *Holcus lanatus*, and *Agrostis alba*. The following grasses have also been examined but do not appear to function as winter hosts for any of the above three species of flies:—*Lolium italicum*, *Poa pratensis*, *P. trivialis*, *P. annua*, *Agrostis vulgaris*, *Alopecurus agrestis*, *Arrhenatherum avenaceum*, *Anthoxanthum odoratum*, *Avena pubescens*, *Cynosurus cristatus*, and *Dactylis glomerata*.

Winter Barley and Wheat are also attacked by all three species; the conditions under which they are attacked by *Chlorops* will be dealt with in detail in a later paper. The effect on the host of either *Meromyza* or *Balioptera* is very similar to that of Frit Fly. The larvæ live in the base of the shoot and destroy the growing point, causing also the yellowing and death of the central leaves by destroying their basal regions. Winter is passed in the larval state. In spring the larva turns round in the grass shoot until its head is directed upwards, ascends a short distance up the shoot, and then pupates.

Summary.

The external and internal anatomy of the mature larva of *Chlorops tæniopus* are described in detail.

The external anatomy of the first and second larval instars is compared with that of the third instar and points of difference noted. The puparium and the egg are also described.

The external anatomy of the third larval instar and the puparium of *Meromyza nigriventris* and of *Balioptera combinata* are described and compared with the corresponding stages of *Chlorops tæniopus*.

The winter host-plants of the three species are given, together with a list of eleven grasses which have been examined but do not serve as winter hosts for any of the above species.

Reference Lettering of Text-Figures.

a. antenna.
a.sp. anterior spiracle.
b. bulb of stigmatic trunk.
b.h. branching hair of posterior spiracle.
c.p.b. cephalo-pharyngeal band.
c.p.s. cephalo-pharyngeal sclerites.
c.r. cephalic chitinous ridges.
c.r.t. "teeth" on cephalic chitinous ridges.
c.s.o. cephalic sense organ.
d.m. dilator muscles of pharynx.
d.v. dorsal vessel.
f. fissures in stem of anterior spiracle of *Balioptera*.
f.c. felted chamber of spiracle.
hy. hypodermis.
i.s. intermediate sclerite.
i.s.p. peduncle of cephalic imaginal sac.
l. labium.
l.b. lateral tracheal branch.
l.f. lateral flap of cephalo-pharyngeal band.
l.p. labial palp sense organ.
l.t. dorso-lateral tracheal trunk.
m. mandible.
m.n. median nerve.
m.nu. muscle nucleus.
m.p. maxillary palp.
m.pl. mediate plate of cephalo-pharyngeal band.
m.v.l. median ventral sclerite.
p.g. proventricular ganglion.
ph. pharynx.
p.n. proventricular nerve.
p.o. pre-oral sense organ.
pr. proventriculus.
p.s. pharyngeal sclerite.
p.sp. posterior spiracle.
r. ridge on bulb of stigmatic trunk.
s. spiracular opening.
s.c. stigmatic scar.
s.m. sheathing membrane of anterior spiracle.
s.p. stigmatic plate.
s.pr. suspensory process of Weismann's ring.
t.c. transverse commissure.
t.s.o. thoracic sense organ.
v.l. vestigial leg sense organ.
v.s. vertical suspensor of dorsal vessel.
v.t. vestigial stigmatic trunk.
w.r. Weismann's ring.
X. point of junction of salivary duct with pharynx.
Y. opening of dorsal vessel into supra-œsophageal sinus.

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40. A Revision of the Isopod Genus *Ligidium* (Brandt)*—Crustacea. By Harold Gordon Jackson, F.Z.S., Birkbeck College, University of London.

[Received July 13, 1923: Read November 6, 1923.]

(Text-figures 1–10.)

Contents.

(1) *Introduction.*

The genus *Ligidium* was separated from *Ligia* by Brandt in 1833 with this diagnosis: "Articulus appendicis caudalis apicalis exterior articuli basalis apici interius autem processui proprio ex articuli basalis apice prodeunti insertus." It is well defined in structure and habitat from *Ligia*, although nearer to that genus than to any other Terrestrial Isopod and linked to it by the newly-described genus *Ligidioides* Wahrberg (1922); and there is but slight range of structure within it. Budde-Lund (1885) gives five species which he describes in Latin with the utmost brevity and without figures. The most important and indeed often the only character given is the form of the uropod, but as the appendage is brittle and often lost, it is sometimes impossible to make a certain identification from his description. I only retain two of these species, but several good species have been added since Budde-Lund's work, and his collection contains specimens, mostly unidentified by him, which have enabled me to describe all but four species. The revision of this genus has been greatly aided by a recent paper by Verhoeff (1918) dealing with the European species, in which much-needed new characters are proposed, and a new subgenus, *Typhloligidium*, is set up, on, to my mind, amply sufficient grounds, to contain Carl's cave-dwelling *Ligidium cœcum.*

* This paper is the second of a series.

(2) *Generic and Specific Characters.*

I have not found any marked sexual dimorphism to occur in *Ligidium*, the difference between the sexes being confined to the modified pleopods of the male. In some species of *Ligia* the sutures separating coxal plates from tergite are differently marked in the sexes. It is interesting to note that no such difference is to be found in this genus, and that the sutures are marked, if at all, in an entirely different manner by fine semicircular grooves on the last four thoracic somites of both sexes (text-fig. 7, *a*).

The *proportions* of the body and the *size* vary remarkably little.

The *colour* of preserved specimens is of little value, but the distribution of the pigment is sometimes characteristic and always worth noting.

The general *surface* of the body is remarkably smooth and polished in all but two species, which have a roughened appearance owing to the presence of scales or knobs.

Cephalon. The line of the epistome is continuous. Above and between the insertion of the antennæ it forms a downwardly-directed V, which differs in length and sharpness in different species. When prolonged and sharp it commonly projects forward to form a slight triangular rostrum. This condition is termed "produced" in the following descriptions (text-fig. 7, *b*). The eyes are moderately large in all species of the subgenus *Ligidium*, and occupy the lateral corners of the head. In front of the hind margin of the cephalon is a more or less deep trench ("transverse groove"), opening to the cheek more or less behind the eye on each side. The two pear-shaped pits on the forehead of *Ligia* are represented in this genus by grooves ("frontal grooves") which originate behind the eyes in the transverse groove, run forwards on the inner side of the eyes, and turn inwards on the top of the head to run towards each other parallel to the transverse groove. They never meet in the mid-line, but end abruptly. The demarcation of these grooves has some systematic value. (Text-figs. 3, *b*; 7, *b*.)

The *thoracic somites* vary little in general form. The hind margins of the first three are more or less straight, the fourth is slightly concave, and the remainder more deeply so owing to the backward production of the lateral corners. These are never, however, much produced. The first somite usually differs from the remainder, as has been pointed out by Verhoeff (1901). In many species the tergite is dinted on the postero-lateral corner of each side, and the dint may take the form of a wide shallow pit or of a shallow groove forming a "re-entrant" from the hind border of the tergite (text-fig. 3, *c* & *d*). In either case it superficially appears as if the tergite had been carelessly nipped by a fine pair of forceps. This structure is referred to hereafter as the "lateral depression." When the depression is extended to the hind border of the tergite, there is often present on its hind edge a patch of stiff bristles arranged in about three transverse rows, forming, as it were, a thick fence of stakes at the entrance to the little valley. Verhoeff (1918) has suggested that this apparatus may be used as a comb for cleaning the antennæ, but confirmatory observations have yet to be made.

The edges of the tergites are beset with "Schuppenborsten" similar to those of *Ligia*, as described by Wahrberg—that is to say, the bristle usually projects slightly, but never conspicuously from the scale; it is sometimes not easy to detect.

The *abdomen* (metasome) is always abruptly contracted. The first two somites are covered by the last thoracic somite, and are without drawn-out pleural plates, but the remaining somites have these moderately drawn out. The terminal somite is very similar in form in all species. The hind border is arcuate or very bluntly angled in the median line; it is notched above the insertion of the uropods to a greater or less extent in different species, but no distinctive angles or spines are developed.

Appendages.

The *antennæ* (antennules) are of three segments, the distal of which is almost vestigial. They always project beyond the front of the head in this genus. Sensory bristles are found on each segment and a terminal bunch on the last of a few short stiff rods. (Text-fig. 2, *a.*)

2nd antennæ. Five segments and an obscurely segmented flagellum of not more than 15 or less than 9 segments, ending in a dense brush of setæ. In the subgenus *Typhloligidium* the flagellum has 19–23 segments. The number of segments on the flagellum appears to increase in number till fully adult. (Text-fig. 2, *b.*)

Right mandible. Three strong biting teeth; large lacinia mobilis beset with many strong bristles, but not chitinized; 3 hairy setæ between biting teeth and molar tubercle on base of lacinia mobilis. Molar tubercle not high-crowned, and bearing a dense row of setose bristles on its free posterior edge. A bunch of long non-setose bristles between lacinia mobilis and molar tubercle. (Text-fig. 1, *a* & *c.*)

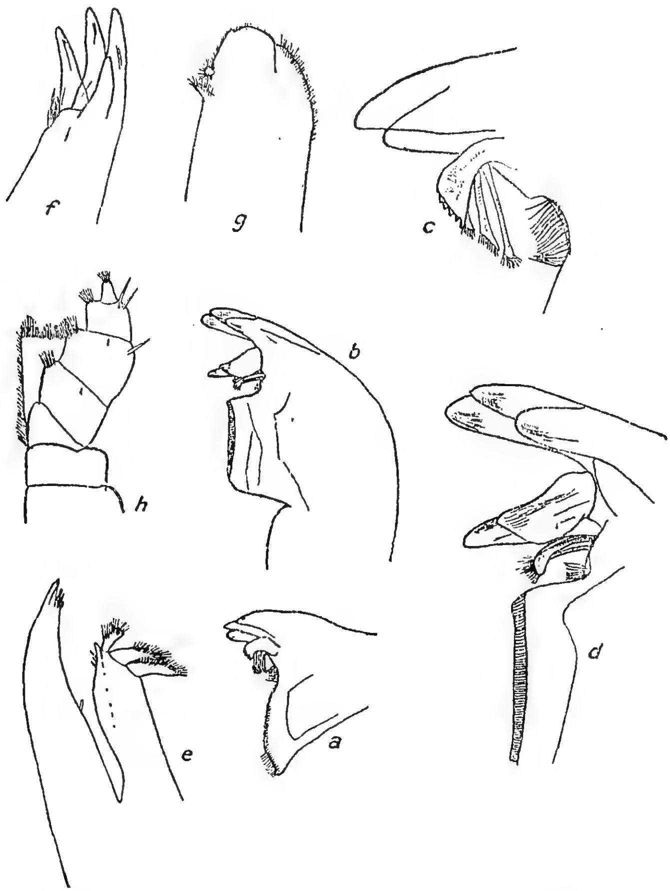
Left mandible. Three or four strong biting teeth; lacinia mobilis with 3 chitinized teeth; 3 or 4 hairy bristles between biting teeth and molar tubercle on base of lacinia mobilis. Molar tubercle high-crowned; its surface strongly ridged. (Text-fig. 1, *b* & *d.*)

1st maxilla. Lacinia exterior with 4 large teeth and 3 or 4 small ones. Lacinia interior with three very stout hairy bristles, the two inferior of which are equal and larger than the uppermost one. (Text-fig. 1, *e* & *f.*)

2nd maxilla. Obscurely divided into two lappets, the smaller on the outer side; on the inner side are seen two richly setose bristles, the upper of which is small and rounded, the lower larger than the upper and blade-shaped. (Text-fig. 1, *g*.)

Maxillipedes. Endopodite distinctly divided into 5 segments, the distal one ending in a blunt cone; on inner side of all but proximal one a prominent bunch of about 7–9 bristles. The

Text-figure 1.



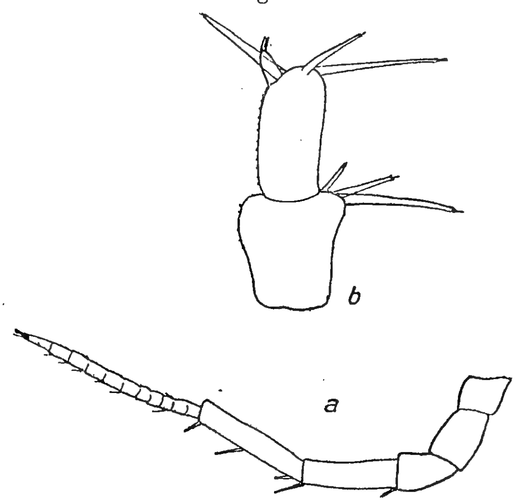
Ligidium hypnorum. *a* & *c*, right mandible; *b* & *d*, left mandible; *e* & *f*, 1st maxilla; *g*, 2nd maxilla; *h*, maxillipede.

inner blade densely covered with plain and setose bristles on the apex. (Text-fig. 1, *h*.)

Peræopods. Typical in form and without distinctive features. The bristles are of simple form, ending in two spikes with a median small "hair." A single bristle projects beyond the unguis in all species but *L. japonicum*, in which, according to Verhoeff, the 7th foot has four ciliated bristles projecting beyond the unguis.

Pleopods. In the male the 1st and 2nd pairs are modified. The 1st endopod is drawn out on the inside into a process upon which is set a variable but small number of setæ. The 1st exopod has also setæ on the postero-median corner. The 2nd endopod is of two segments and greatly elongated. The inner edge is thickened, and the outer appears to be folded over in some forms. At the end of the distal segment this fold sometimes becomes a wide lappet, which shows considerable individual variation in size and shape. Verhoeff bases a key on the characteristics of the male pleopods, but although my material is not conclusive, I do not feel disposed to allow much importance

Text-figure 2.



Ligidium hypnorum. *a*, antenna; *b*, antennule.

to them. I suspect that they appear different in forms collected during and out of the breeding-season. (Text-figs. 3, *e*; 4, *a* & *b*; 6, *d*, *e* & *f*; 8, *c* & *d*; 10, *c* & *d*.)

Uropods. The striking inequality of the two rami and the characteristic inner process of the base make these appendages systematically valuable, a fact which causes their brittleness to be all the more regrettable. Budde-Lund divides the species dealt with by him into two groups—the first in which the exopod is longer than the endopod, and the second in which the reverse is the case. Further knowledge has shown that the first group contains but two species—the common *L. hypnorum* and *Typhloligidium cæcum*,—and that all the other known forms fall into the second group. The grouping does not seem to be of primary importance. (Text-figs. 4, *c*; 6, *g*; 8, *e*; 9, *c*; 10, *e*.)

(3) *Key to the genus* Ligidium.

The diagnoses of the genera *Typhloligidium* and *Ligidium* s.s. are taken from Verhoeff (1918) with one omission.

A. Eyes and body-pigment absent. Antennal flagellum 19–23 segments. Mandibles with large interval between the biting teeth and triturating part; in intervening space 10–11 hairy bristles. Uropods widely separated.
Subgenus *Typhloligidium* Verh.
One species, *T. cœcum* (Crimea—caves).

B. Eyes large, body-pigment well developed. Antennal flagellum 10–15 segments. Mandibles with 3–5 hairy setæ, their biting teeth and triturating part not widely separated.. Subgenus *Ligidium* Verh.

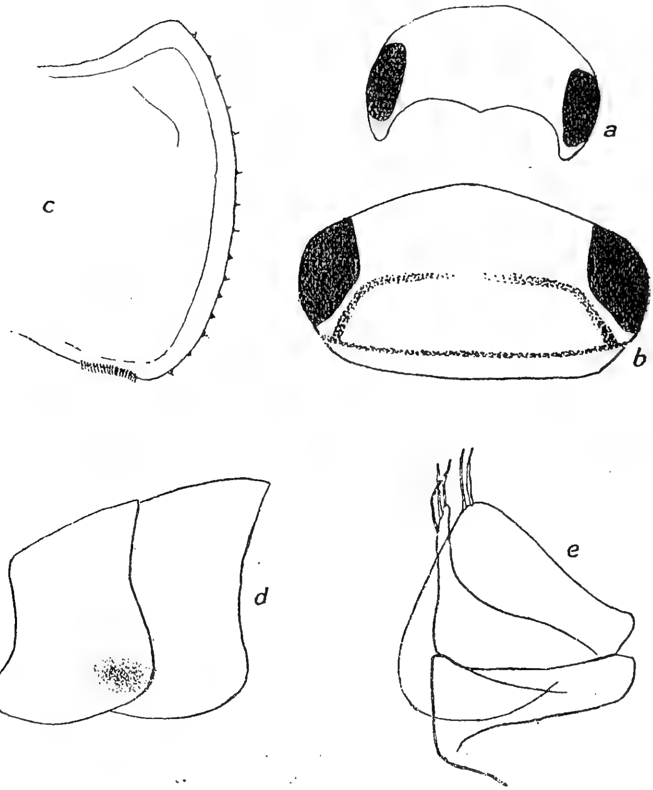
1.	With bristle group on hind lateral border of 1st somite..	2.
	Without bristle group....................................	6.
2.	With lateral depression on hind border of 1st somite	3.
	Without lateral depression	*germanicum* (Central Europe).
3.	Surface covered with little knobs	*nodulosum* (Caucasus).
	Surface smooth and shining	4.
4.	Endopod of uropod longer than exopod	*hypnorum* (Europe).
	Exopod longer than endopod	5.
5.	Frontal grooves deep and distinct	*bosniense* (S. Bosnia).
	Frontal grooves absent or very shallow..............	*fragile* (Caucasus).
6.	Surface rough and scaly	*latum* (California).
	Surface smooth and shining	7.
7.	Inner process of propodite of uropod shorter than breadth of base	*joponicum* (Japan).
	Inner process longer than breadth of base	8.
8.	Endopod less than one-sixth longer than exopod...	*gracile* (California).
	Endopod about half as long again as exopod	*longicaudatum* (New York).

(4) *The genus* Ligidium.

The diagnosis given below is modified from Sars (1899).

Body oblong oval, moderately convex, attenuated behind. Cephalon without lateral lobes. Mesosome with coxal plates marked off from tergite by faint semicircular grooves on last four somites. Metasome moderately small and abruptly contracted, without produced postero-lateral angles on last somite. Eyes large and compound. Antennula of 3 segments, small, distal segment rudimentary, but distinctly projecting in front of head. Antenna with multi-articulate flagellum of 10–15 (*Ligidium*) or 19–23 (*Typhloligidium*) segments. Mandible with lacinia mobilis and 3–5 (*Ligidium*) or 10–11 (*Typhloligidium*) setose bristles between it and the molar tubercle. 1st maxilla with 3 stout setose bristles on interior lacinia. 2nd maxilla membranous, with 2 stout setose bristles on inner side. Maxillipede with endopod of 5 distinct segments; inner blade linguiform and setose. Legs very slender and greatly increasing in length posteriorly. Opercular plates of pleopoda very thin, without any obvious branchial structure. Uropoda moderately large, base produced on inner side into a process upon which the endopod is set; endopod usually longer and more slender than exopod and provided with 2 long and slender apical bristles.

Text-figure 3.



Ligidium hypnorum. *a*, head from front; *b*, head from above; *c*, 1st tergite, lateral edge; *d*, 1st and 2nd tergites from side; *e*, 1st pleopod, ♂.

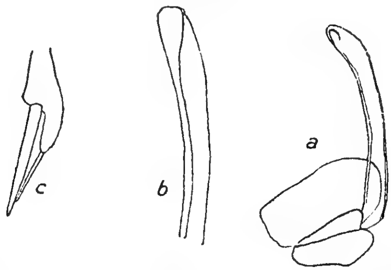
1. Ligidium hypnorum (Cuvier). (Text-figs. 1, 2, 3, 4.)

Oniscus hypnorum Cuvier, 1792, p. 19. *Ligidium personii* Brandt (1833), p. 173. *Ligia melanocephala* Koch (1847), H. 22 (162), 18. *Zia melanocephala* Koch (1847), Zusammenstellung, p. 212. *Z. paludicola* Koch (1847), H. 34 (180), 21. *Ligidium amethystium* Schöbl (1861), p. 311. *L. hypnorum* Stuxberg (1875); Budde-Lund (1885), p. 254 (*q. v.* for other references). *L. cursorium* Budde-Lund (1885), p. 256. *L. hypnorum* Michaelsen (1897), p. 132; Sars (1899), p. 157; Verhoeff (1901), p. 40. *L. melanocephala* Koch (1901), p. 69. *L. hypnorum* Koch (1901), p. 69; Richardson (1905), p. 686; Verhoeff (1918), p. 114; Dahl (1916 & 1917).

Length: ♂ 6 mm., ♀ 7·5 mm. *Breadth*: ♂ 2·5 mm., ♀ 3·5 mm. *Surface* smooth and shining. *Head.* Frontal margin slightly sinuate; median V very obtuse and almost linear, not produced. Transverse groove deep and passing behind eyes. Frontal grooves well marked, joining transverse groove at obtuse angle behind eyes. Eyes large and pear-shaped. *Thorax.* 1st somite with deep lateral depression on each side, extending to hind border. On hind border of depression a dense bristle group. Coxal plates: sutures well marked on last four somites in both sexes; moderately drawn backwards on last three somites. *Antennal* flagellum reaching back as far as hind margin of 2nd thoracic somite; with 11 segments. *Uropods.* Inner process of base long, curved, and nearly as long as base. Endopod by itself not more than half exopod; combined with inner process reaching nearly as far, or as far as, but not beyond, tip of exopod. Exopod about three times as long as inner process. *Telson* arcuate; not notched or only faintly notched over uropods.

Pleopods of ♂. 1st exopod with 2 or 3 large setæ; 1st endopod drawn out internally into long narrow process with 3 large

Text-figure 4.



Ligidium hypnorum. *a*, 2nd pleopod, ♂; *b*, endopod of same from another specimen; *c*, uropod from above.

bristles; terminal segment of 2nd endopod with rounded or almost triangular lappet.

Colour. Brown and yellow mottled. Dark more or less continuous band over junction of coxal plates and tergites.

Distribution. Europe; California; Niagara (Canada). This species has not been recorded from N. America since Stuxberg (1875), on which Budde-Lund (1885) comments, "quid mihi minus verisimile videtur."

Figured in full by Sars (1899).

I have included *L. cursorium* Budde-Lund and *L. melanocephala* Koch as synonyms of this species after a minute examination of the original specimens. Verhoeff rightly conjectures that *L. cursorium* is a large variety of *L. hypnorum*, and as such I have distinguished it. *L. melanocephala* is a colour variety, with slight structural features to separate it from *L. hypnorum*. I agree with Verhoeff that *L. amethystium* is almost certainly a synonym.

Varieties.

L. hypnorum, var. *cursorium* (Budde-Lund). *Length* 9 mm. *Breadth* 4 mm. Frontal margin sinuate, median V blunt and slightly produced. Frontal grooves shallow. Colouring as in *L. hypnorum.* Inner process of uropod base perhaps a little shorter than in *L. hypnorum.*

L. hypnorum var. *atromaculatum* Verh. The dark markings make 2 longitudinal bands on the tail in front of the telson.

L. hypnorum var. *melanocephala* (Koch). Body very convex above; antennal flagellum 9–12 segments; fourth segment of antenna scarcely longer than the third; colour predominantly dark brown.

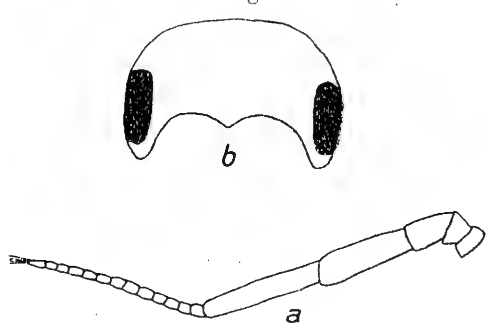
2. Ligidium fragile Budde-Land. (Text-fig. 5.)

Ligidium fragile Budde-Land (1885), p. 257.
Ligidium euxinum Verhoeff (1918), p. 114.

Length 7·5 mm. *Breadth* 3·5 mm.

Surface smooth and shining. *Head.* Frontal margin sinuate; median V moderately sharp; not produced. Transverse groove deep and narrow, and passing behind eyes; frontal groove very shallow and joining transverse groove abruptly. Eyes large and pear-shaped. *Thorax.* 1st somite with lateral depression on each

Text-figure 5.



Ligidium fragile. *a*, antenna; *b*, head from front.

side extending to hind border. On hind border of depression a bristle group. Coxal plates: sutures faintly marked on last four somites; slightly drawn backwards on last three somites. *Antennal* flagellum reaching back as far as halfway across 3rd thoracic somite; with 12–15 segments. *Uropods.* Inner process of base nearly as long as base; endopods reaching further back than exopod; exopod about twice as long as inner process. (I have not seen a complete uropod.) *Telson.* Sides obtuse-angled and with slight notch over uropods.

Colour. Mottled brown and yellow; median yellow stripe from head to tail; legs yellow.

Distribution. Caucasia, Crimea.

Verhoeff's suspicion that his *L. euxinum* can be brought into relation with Budde-Lund's *L. fragile* proves to be well founded on further examination of Budde-Lund's material. I have no hesitation in placing it as a synonym of that species.

Variety.—L. fragile caucasium Verhoeff (1918). Epimera of thorax predominantly coloured with irregular brown marks. Hind angle of tergite of 2nd somite with similar depressions to 1st tergite. Antennal flagellum with 11 segments.

3. Ligidium gracile (Dana). (Text-fig. 6.)

Styloniscus gracilis Dana (1856), p. 176.
Ligidium tenue Budde-Lund (1885), p. 258.
Ligidium gracilis Holmes (1904), p. 318; Richardson (1905), p. 690 (*q.v.* for other references).
Ligidium gracile Verhoeff (1918), p. 114.

Length: ♂ 7 mm., ♀ 9 mm. *Breadth*: ♂ 2 mm., ♀ 3 mm.

Surface smooth and shining. *Head.* Frontal margin sinuate; median V sharply drawn out and produced to slight rostrum. Transverse groove deep and short, reaching to inner edge of eyes. Frontal grooves obsolete or very faintly indicated. Eyes rather small and somewhat pear-shaped. *Thorax.* 1st somite finished with bristles at regular intervals on lateral edges, none on posterior margin. A deep lateral depression on each side reaching hind border. No bristle group. Coxal-plate sutures distinctly marked on last four somites in both sexes; drawn backwards on last three somites only, the 5th somite little if at all drawn back. *Antennal* flagellum reaching back to hind margin of 2nd somite; with 12 segments. *Uropods.* Inner process of base stout, slightly curved and about half as long as base. Endopod by itself slightly longer than exopod; combined with inner process exceeds exopod by about one-sixth of the latter. Exopod about four times as long as inner process. *Telson* with blunt postero-lateral angles moderately deeply notched over uropods.

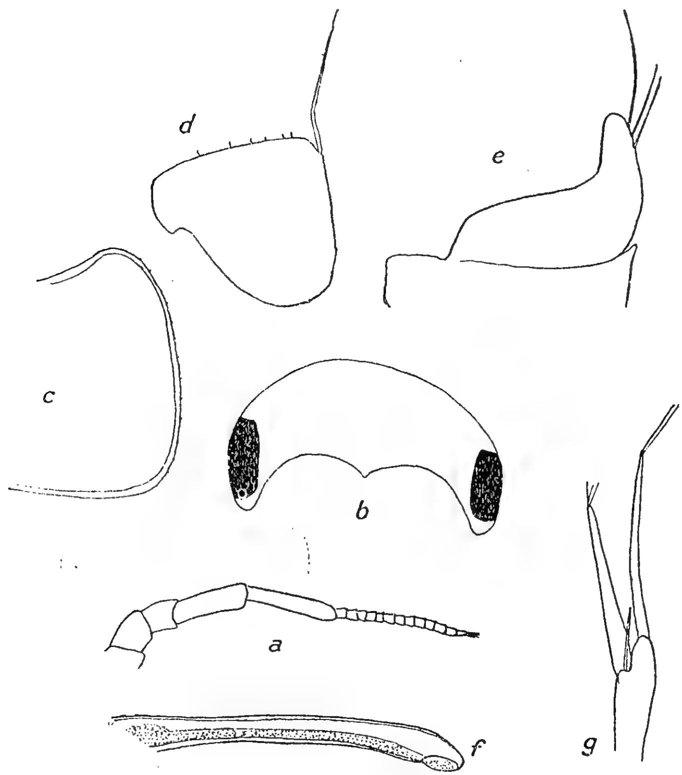
Pleopods of ♂. 1st exopod with one long bristle; 1st endopod with process moderately drawn-out and blunt, with 3 bristles; 2nd endopod with small rounded lappet.

Colour. Brown ground; brown median stripe; mottled on each side with yellow. Yellow stripe along and above sutures of coxal plates, which are brown on each side. Legs yellow. Head mottled.

Distribution. California, St. Clara; Massett (British Columbia). Sitka Island. San Francisco.

The specimens in Budde-Lund's collection that he has identified with *L. gracile* Dana are from St. Clara (California). They differ in slight particulars from Holmes's (1904) description of Dana's material; the antennæ (judging by Holmes's imperfect figure) are shorter, but as Dana's specimens are larger than these, the point is not of much systematic value; the eyes of Dana's specimens are described as "rather large"—a verbal difference depending on an unknown standard. These specimens have smaller eyes than the average in *Ligidium*. There cannot be much doubt that they are the same, however.

Text-figure 6.



Ligidium gracile. *a*, antenna; *b*, head from front; *c*, 1st tergite, lateral edge; *d*, *e* & *f*, 1st and 2nd pleopods of ♂; *g*, uropod from below.

The specimens from British Columbia are labelled with an unpublished name by Budde-Lund. They are, however, specifically identical with *L. gracile*, but have interesting differences that entitle them to rank as a variety. Melanin pigment is entirely absent, and the eyes are slightly smaller. I have no history to these specimens, but one may surmise that they are cave varieties of *L. gracile.*

Budde-Lund (1885) described from Sitka Island a species, *L. tenue*, but the only important points in his description are the detail of the uropods and the size. These agree closely enough with *L. gracile* to justify a provisional inclusion of the species in the synonymy of *L. gracile*, but I have seen no specimens.

Figures in Richardson (1905).

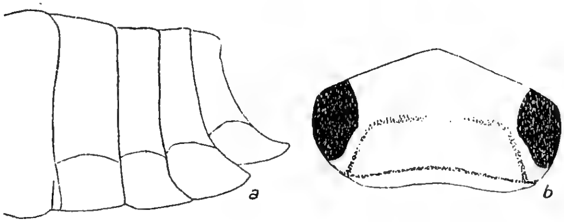
Variety.—*L. gracile* var. *flavum*, n. var. Pigment entirely absent. Eyes rather small, round, and not reaching to lateral margin of head.

4. Ligidium latum, sp. n. (Text-figs. 7 & 8.)

Length: ♂ 6 mm., ♀ 8·5 mm. *Breadth*: ♂ 3 mm., ♀ 4 mm.

Surface rough and covered with small scales. *Head.* Frontal margin sinuate; median V very sharp and produced. Transverse groove deep and passing behind eyes; frontal grooves very deep and curving back to join transverse groove abruptly. Eyes large and pear-shaped. *Thorax.* 1st somite without lateral depressions or bristle groups. Setæ at intervals on lateral border, but absent on posterior border. Coxal-plate sutures well marked on last four somites in the female, only lightly marked on last two in male; well drawn backwards on last three somites and slightly on fourth somite. *Antennal* flagellum long, reaching back as

Text-figure 7.



Ligidium latum. *a*, last four thoracic somites from left side; *b*, head from above.

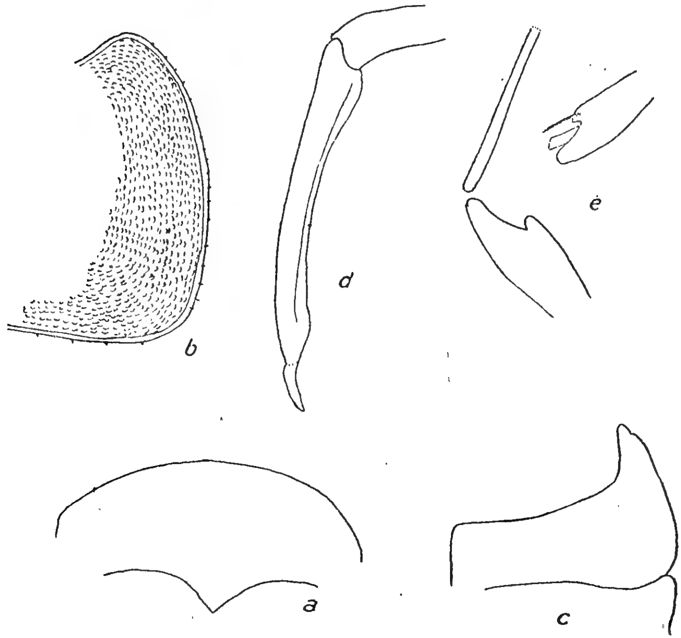
far as hind margin of 4th somite; with 12 segments. *Uropods.* Inner process of base shorter than base by about half its length, stout and conical. (None of my specimens have undamaged uropods.) The single seta arising from outer side of base, set on sharp and pointed process. *Telson* deeply notched over uropods; blunt, rounded postero-lateral angles.

Pleopods of ♂. 1st exopod with one (?) bristle; 1st endopod with moderate process and one (?) bristle; 2nd endopod ending in pointed process.

Colour. Brown and yellow mottled; slightly lighter streak down middle of back. Coxal plates light and sharply defined from brown of tergite at the suture. Legs banded with yellow and brown.

Distribution. San Francisco.

Text-figure 8.



Ligidium latum. *a*, head from front; *b*, 1st tergite, lateral edge; *c* & *d*, endopod of 1st and 2nd pleopods, ♂; *e*, uropod from below.

This species is distinguished from all but *L. nodulosum* by its very distinctive rough surface. It differs from that species in the character of the granulations and the form of the 1st somite.

5. Ligidium germanicum Verhoeff. (Text-fig. 9.)

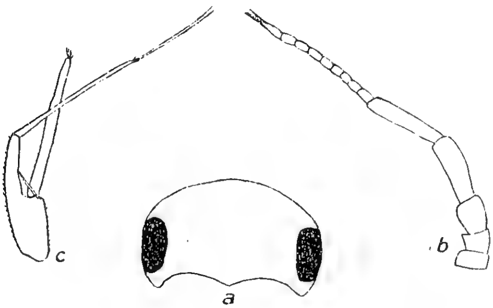
Ligidium germanicum Verhoeff (1901), p. 41; Verhoeff (1918), p. 114.

Ligidium herzegowinense Verhoeff (1918), p. 114; Dahl (1916 & 1917).

Length 7 mm. *Breadth* 2·5 mm.

Surface smooth and shining. *Head.* Frontal margin slightly sinuate, median V almost obsolete, not produced. Transverse groove deep and passing behind eyes; frontal grooves shallow and curved, passing into transverse groove at less than a right angle. Eyes large and pear-shaped. *Thorax.* 1st somite without lateral depressions or bristle groups. Coxal plates: sutures faintly visible on last three somites of male, very faint or obsolete on female; hind corners of last three but little drawn out. *Antennal* flagellum reaching back as far as halfway across 3rd somite; stout and somewhat setose; with 9–10 segments. *Uropods.* Inner process of base curved and longer than base. Endopod by itself about as long as exopod; combined with inner process exceeding exopod by about one-third of the latter. Exopod about twice as long as inner process; setæ of endopod

Text-figure 9.



Ligidium germanicum. *a*, head from front; *b*, antenna; *c*, uropod from below.

about three-quarters as long as that branch. *Telson* arcuate, inclining to a bluntly angulate condition in some; no notch above uropods.

Pleopods of ♂. Similar to *L. hypnorum.*

Colour. Predominantly brown, mottled with yellow; legs yellow.

Distribution. Central Europe.

6. Ligidium japonicum Verhoeff. (Text-fig. 10.)

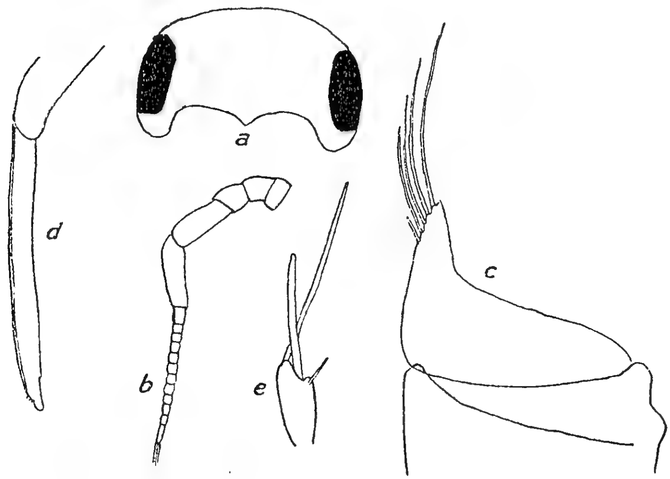
Ligidium japonicum Verhoeff (1918), p. 114.

Length 6 mm. *Breadth* 2·5 mm.

Surface smooth and shining. *Head.* Frontal margin sinuate, forming moderately sharp V; not produced. Transverse groove narrow and deep, and passing behind eyes. Frontal grooves shallow, joining transverse grooves abruptly. Eyes large and pear-shaped. *Thorax.* 1st somite with deep lateral depressions; no bristle groups, but a group of little processes lies in each depression. Coxal plates: sutures not visible; hind corners of last three slightly drawn out. *Antennal* flagellum reaching as far back as hind margin of 3rd thoracic somite; with 14 segments; long and setose. *Uropods.* Inner process of base short and blunt, hardly one-third base and shorter than width of base. Endopod by itself about half as long again as exopod, combined with inner process nearly two-thirds as long again. Exopod about six times as long as inner process. *Telson.* Only slightly notched above uropod; no postero-lateral production.

Pleopods of ♂. 1st exopod with 5–6 large setæ; 1st endopod drawn out internally into sharp triangular process with 5–6 large setæ; 2nd exopod "divided very distinctly by a suture in two parts" (Verhoeff); 2nd endopod with small rounded projecting terminal lappet and three small spines on inner edge at distal end.

Text-figure 10.



Ligidium japonicum. *a*, head from front; *b*, antenna; *c* & *d*, endopod of 1st and 2nd pleopods, ♂; *e*, uropod from below.

Colour. Light brown with whitish speckling; longitudinal band of large spots over coxal plates; median brown band without mottling; legs whitish.

Distribution. Japan; "Moheri" (Japan).

Figured by Verhoeff (1916).

I have not seen specimens of the following species:—

7. Ligidium bosniense Verhoeff.

Ligidium bosniense Verhoeff (1901), p. 40; (1918), p. 114.

Distribution. Sarajevo, Bosnia.

Briefly described but not figured.

8. Ligidium nodulosum Verhoeff.

Ligidium nodulosum Verhoeff (1918), p. 114.

Distribution. Caucasus.

Described with figures by Verhoeff.

9. Ligidium longicaudatum Stoller.

Ligidium longicaudatum Stoller (1902), p. 208; Richardson (1905), p. 688; Verhoeff (1918), p. 114.

Distribution. New York.

Verhoeff remarks of this species that the figure given by Stoller can scarcely be accepted. The descriptions are also inadequate, and the specimens should be redescribed in the light of recent work.

10. Ligidium (Typhloligidium) cœcum (Carl).

Ligidium cœcum Carl (1905), p. 327.

Typhloligidium cœcum Verhoeff (1918), p. 114.

Distribution. Crimea, in caves.

Verhoeff supplements Carl's description, but no new figures have been given. Carl figures the telson and uropods and the second pleopod of the male.

I wish to acknowledge my debt to Dr. W. T. Calman, F.R.S., for allowing me the use of the British Museum material, and for his readiness in advising on questions of Crustacean morphology and literature.

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Stuxberg, A.—1875. "Om Nord-Amerikas Oniscider." Öfversigt K. Vetenskaps-Akad. Förhandl. xxxii. 2, pp. 43–63.

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Wahrberg, R.—1922. "Terrestre Isopoden aus Australien." Arkiv f. Zool. xv. 1, Stockholm. Text-figs.

41. A List of the Lizards of British Territories in East Africa (Uganda, Kenya Colony, Tanganyika Territory, and Zanzibar), with Keys for the diagnosis of the Species. By ARTHUR LOVERIDGE, F.E.S., C.M.Z.S.

[Received October 3, 1923: Read October 23, 1923.]

As no work on the Lizards of the British territories in East Africa, as a whole or in part, has ever appeared in the English language, the writer hopes that the accompanying keys and check-list may prove of use to his fellow herpetologists and perhaps help to stimulate an interest in the Lizards of this region.

Both Tornier* and Nieden† have published works dealing with the reptile fauna of German East Africa (now Tanganyika Territory) and have included in these many species from British East Africa (now Kenya Colony) and Uganda likely to be found in G. E. A. Owing to the many species described by Boulenger, Sternfeld and others, however, both these works may be considered out of date.

Like all herpetologists, I must confess my indebtedness to the writings of Mr. G. A. Boulenger. In the case of the Lizards proper (Lacertidæ) I have adopted, or extracted, from his keys‡ to suit my purpose.

Out of the 112 species and races considered valid in this paper, no fewer than 64 have been described since the publication of his 'Catalogue of Lizards'§. A still more significant fact as to the amount of work done in recent years is that, of the 48 species which appear in the Catalogue, only 15 are recorded from, or credited to, the area dealt with in the following pages, which have perforce been compiled from a mass of papers that have appeared since 1887.

Number of Species characterised.

	By Blgr. 1885–87.	Torn. 1897.	Nied. 1913.	Present paper, 1923.
Geckonidæ	1	11	16	25
Agamidæ	1	8	6	13
Zonuridæ	0	2	4	4
Varanidæ	0	3	3	3
Amphisbænidæ	1	0	4	5
Lacertidæ	3	6	13	20
Gerrhosauridæ	1	3	2	4
Scincidæ	8	17	24	37
Anelytropidæ	0	1	1	1
Totals	15	51	73	112

* Tornier, 'Die Kriechtiere Deutsch-Ost-Afrikas,' 1897, and Zool. Jahrb. Syst. xiii. Band 6, 1900.

† Nieden, 'Neues Verzeichnis der Kriechtiere . . . von Deutsch-Ost-Afrika,' 1913.

‡ Boulenger, 'Monograph of the Lacertidæ,' i. & ii. 1920–21.

§ Boulenger, 'Catalogue of the Lizards in the British Museum,' i.–iii. 1885–1887.

As brevity is so essential in a key I have omitted lists of bibliographical references, giving in the case of those 50 species appearing in the 'Catalogue of Lizards' the volume and page reference of that work only, in the case of those subsequently described only the reference to the publication in which its description first appeared.

The synonyms, which are also numerous, have been omitted for the same reason, and only a few given of recent date which may not be generally known.

With the exception of the generic keys for the Geckonidæ and Lacertidæ, I have been able to arrange my keys according to characters of taxonomic value, so that the genera or species fall into their natural order. In the two generic keys mentioned this was not possible without making them unduly cumbersome.

Synopsis of the Families.

I. Upper surface of head with scales or granular tubercles.
  A. Tongue short with villose papillæ.
    No movable eyelids; dentition pleurodont .... GECKONIDÆ.
    Movable eyelids; dentition acrodont.................... AGAMIDÆ.
  B. Tongue long, smooth, deeply bifid, sheathed at base ... VARANIDÆ.

II. Upper surface of head with large or symmetrical shields.
  A. Tongue with villose papillæ; femoral pores .... ZONURIDÆ.
  B. Tongue with scale-like imbricate papillæ or oblique plicæ.
    Body vermiform; scales soft, squarish, not imbricate. AMPHISBÆNIDÆ.
    No bony plates under the scales; femoral pores usually present .... LACERTIDÆ.
    Bony plates under the scales; a lateral fold; femoral pores present .... GERRHOSAURIDÆ.
    Bony plates under the scales; no lateral fold; no femoral pores; eyes distinct .... SCINCIDÆ.
    Bony plates under the scales; body vermiform; eyes concealed beneath skin................................. ANELYTROPIDÆ.

Family GECKONIDÆ.

Ten genera.

I. Digits not, or but slightly dilated.
  A. Pupil vertical
    No pores .... *Stenodactylus.*
    Præanal pores .... *Bunocnemis.*
  B. Pupil round .... *Gonatodes.*

II. Digits dilated.
  A. Pupil vertical.
    1. Digits with a strong claw.
      a. Sub-digital plates divided.
        Digits dilated at apex only, not at base .... *Diplodactylus.*
        Distal phalanges compressed................................ *Hemidactylus.*
      b. Sub-digital plates undivided.
        Thumb and inner toe clawless .... *Platypholis.*

2. Digits clawless or with a minute claw.

Digits moderately dilated; nostril pierced between the rostral and three small scales	*Pachydactylus.*
Digits strongly dilated; nostril pierced between the rostral, 1st labial, and three small scales	*Elasmodactylus.*

B. Pupil circular.

Sub-digital lamellæ in two rows	*Lygodactylus.*
Sub-digital lamellæ undivided	*Phelsuma.*

1. Stenodactylus.

Fitzing. N. Classif. Rept. p. 13; Blgr. Cat. Liz. i. p. 16.

1. Stenodactylus guttatus Cuv.

Blgr. Cat. Liz. i. p. 17, 1885.

Kenya Colony.

2. Gonatodes.

Fitzing. Syst. Rept. p. 91; Blgr. Cat. Liz. i. p. 56.

Synopsis of the Species.

5 or 6 upper, and 5 or 6 lower labials; 7 to 8 præanal pores	*quattuorseriatus.*
6 or 7 upper, and 7 or 8 lower labials; 8 to 12 præanal pores	*africanus.*

1. Gonatodes quattuorseriatus Stern.

Stern. Ergebn. Deut.-Zentral-Afrika Exp. 1907–08, iv. (Z. 2), p. 202, 1913.

Kenya Colony.

2. Gonatodes africanus Wern.

Gymnodactylus africanus Wern. Verhlg. k. k. zool.-bot. Ges. Wien, 1895, p. 190.

Kenya Colony; Tanganyika Territory.

3. Diplodactylus.

Gray, Proc. Zool. Soc. 1852, p. 40; Blgr. Cat. Liz. i. p. 97.

1. Diplodactylus wolterstorffi Torn.

Torn. Zool. Jahrb. Syst. xiii. p. 584, f. A, 1900.

Tanganyika Territory.

4. Hemidactylus.

Hemidactyles Cuv. R. A. ii. p. 47; Blgr. Cat. Liz. i. p. 113.

Synopsis of the Species.

I. Dorsal tubercles, if present, small, smooth, conical, or very feebly keeled.	
No tubercles; male with six præanal pores	*isolepis.*
Small tubercles on occiput and neck only; male with seven præanal pores	*tropidolepis.*
Feebly keeled scales on body surrounded by a ring of keelless scales; male with 16 præanal pores	*squamulatus.*
Small tubercles; male with 15–30 femoral pores	*mabouia.*
II. Dorsal tubercles present and strongly keeled.	
4 or 5 lamellæ under the inner, and 6 or 7 under the median toe; 8 to 10 upper and 5 or 7 lower labials	*citernii.*
4 or 5 lamellæ under the inner, and 6 to 8 under the median toe; 8 or 9 upper and 7 or 8 lower labials. Head covered with plates more or less equal in size and generally keeled .	*ruspolii.*
4 to 6 lamellæ under the inner, and 7 or 8 under the median toe; 7 to 10 upper and 6 to 9 lower labials. Head covered with granules and scattered oval, keeled shields much larger than the granules	*brookii.*
5 or 6 lamellæ under the inner, and 8 to 10 under the median toe; 9 to 10 upper and 8 or 9 lower labials	*werneri.*
7 or 8 lamellæ under the inner, and 10 to 12 under the median toe; 9 upper and 8 lower labials	*macropholis.*

1. Hemidactylus isolepis Blgr.

Blgr. Proc. Zool. Soc. 1895, p. 531, pl. xxix. fig. 1.
Kenya Colony.

2. Hemidactylus tropidolepis Mocq.

Mocq. Mém. Cent. Soc. Philom. Paris, 1888, p. 113.
Kenya Colony; Tanganyika Territory.

3. Hemidactylus squamulatus Torn.

Torn. Die Kriecht. Deut.-Ost-Afr. p. 10, 1897.
Doubtfully distinct from *H. tropidolepis* Mocq.
Kenya Colony; Tanganyika Territory.

4. Hemidactylus mabouia Mor.

Blgr. Cat. Liz. i. p. 122, 1885.
Kenya Colony; Tanganyika Territory; Zanzibar.

5. Hemidactylus citernii Blgr.

Blgr. Ann. Mus. Civ. st. nat. Genova, ser. 3a, vol. v. (xlv.), 1912.

Kenya Colony; Tanganyika Territory.

6. Hemidactylus ruspolii Blgr.

Blgr. Ann. Mus. Civ. st. nat. Genova, ser. 2, xvii. p. 6, 1896.

Kenya Colony; Tanganyika Territory.

7. HEMIDACTYLUS BROOKI Gray.
Blgr. Cat. Liz. i. p. 128, 1885.
Uganda; Kenya Colony; Tanganyika Territory; Zanzibar.

8. HEMIDACTYLUS WERNERI Torn.
Torn. Arch. Naturg. vi. p. 63, 1897.
Hemidactylus tornieri Mocq. Bull. Mus. Paris, 1902, p. 404.
Kenya Colony; Tanganyika Territory.

9. HEMIDACTYLUS MACROPHOLIS Blgr.
Blgr. Ann. Mus. Civ. st. nat. Genova, ser. 2, xvii. p. 7, 1896.
Kenya Colony.

5. BUNOCNEMIS.

Günther, Proc. Zool. Soc. 1894, p. 85.

1. BUNOCNEMIS MODESTUS Gthr.
Gthr. Proc. Zool. Soc. 1894, p. 85.
Kenya Colony.

6. LYGODACTYLUS.

Gray, Proc. Zool. Soc. 1864, p. 59; Blgr. Cat. Liz. i. p. 158.

Synopsis of the Species.

I. Subcaudal scales small .... *capensis.*
II. Subcaudals enlarged, in two longitudinal rows.
 9 upper and 6 lower labials; 10 præanal pores in male...... *fischeri.*
 5 or 6 upper and 5 or 6 lower labials; 6 præanal pores in male .... *f.* var. *schef-* [*fleri.*
III. Subcaudals transversely enlarged in a single median series. (*L. grotei* may combine subcaudal arrangement of I, II, & III.)
 6 to 10 upper and 5 to 8 lower labials; 4 to 6 præanal pores in male. Throat pure white .... *grotei.*
 5 or 6 upper and 6 or 7 lower labials; 8 to 9 præanal pores in male. Throat usually black in male........................ *picturatus.*
 5 to 7 upper and 5 to 7 lower labials; 8 to 9 præanal pores in male. Throat usually with chevron-shaped markings. *p. gutturalis.*

1. LYGODACTYLUS CAPENSIS Smith.
Blgr. Cat. Liz. i. p. 160.
Tanganyika Territory.

2. LYGODACTYLUS FISCHERI Blgr.
Blgr. Proc. Zool. Soc. 1890, p. 80.
Kenya Colony; Tanganyika Territory.

3. LYGODACTYLUS FISCHERI, var. SCHEFFLERI Sternf.
Sternf. Ergebn. Deut.-Zentral-Afrika Exp. 1907–08, vol. iv. (Z. 2) p. 206, 1913.
Kenya Colony; Tanganyika Territory.

4. Lygodactylus grotei Sternf.
Sternf. S.B. Ges. naturf. Berlin, nr. 4, p. 245, 1911.
Tanganyika Territory.

5. Lygodactylus picturatus Peters.
Blgr. Cat. Liz. i. p. 161.
Kenya Colony; Tanganyika Territory; Zanzibar.

6. Lygodactylus picturatus gutturalis Bocage.
Blgr. Cat. Liz. i. p. 161.
Uganda.

7. Platypholis.

Blgr. Proc. Zool. Soc. 1890, p. 80.

1. Platypholis fasciata Blgr.
Blgr. Proc. Zool. Soc. 1890, p. 81, pl. viii. fig. 2.
Kenya Colony; Tanganyika Territory.

8. Pachydactylus.

Pachydactyles, part., Cuv. Règne Anim. ii. p. 45; Blgr. Cat. Liz. i. p. 200.

Synopsis of the Species.

Dorsal tubercles strongly keeled. Head covered with convex, keeled scales .... *bibronii.*
Dorsal tubercles feebly keeled. Head covered with smooth cone-shaped scales .... *boulengeri.*

1. Pachydactylus bibronii Smith.
Blgr. Cat. Liz. i. p. 201.
Tanganyika Territory.

2. Pachydactylus boulengeri Torn.
Torn. Kriechtiere D. O. A. p. 26, 1897.
Tanganyika Territory.

9. Phelsuma.

Gray, Ann. Phil. (2) x. p. 199, 1825; Blgr. Cat. Liz. i. p. 209.

1. Phelsuma laticauda Bttgr.
Blgr. Cat. Liz. i. p. 215.
P. dubius (Bttgr.), Blgr. Cat. Liz. i. p. 215.
Tanganyika Territory; Zanzibar.

10. Elasmodactylus.

Blgr. Proc. Zool. Soc. 1894, p. 727.

1. Elasmodactylus triedrus Blgr.
Blgr. Rev. Zool. Afr. iii. p. 104, fig., 1913.
Tanganyika Territory.

Family Agamidæ.

Two genera.

I. Incisors small, conical .... *Agama.*

II. Incisors united into one or two large cutting teeth; tail short, with whorls of spines .... *Aporoscelis.*

1. Agama.

Agama, part., Daud. Hist. Rept. iii. p. 333; Blgr. Cat. Liz. i. p. 334.

Synopsis of the Species.

I. Occipital scale enlarged.
A. Dorsal scales unequal.
Ventral scales keeled.. *hispida.*
Ventral scales not or but slightly keeled .... *h. distanti.*
B. Dorsal scales equal.
1. A slight denticulation or crest on the vertebral line.
Smooth or keeled ventrals much smaller than the dorsals. *mossambica.*
Smooth ventrals scarcely smaller than the dorsals .... *kirkii.*
2. No dorsal denticulation or crest.
a. A small nuchal crest.
Longest spines about ear and on sides of neck about half the diameter of the ear-opening; dorsal scales strongly keeled .... *doriæ.*
Longest spines about ear and on sides of neck one-third the diameter of the ear-opening; dorsal scales keeled, not or but very slightly mucronate .... *planiceps.*
Longest spines about ear and on sides of neck considerably shorter than the diameter of the ear-opening; dorsal scales strongly keeled, mucronate .... *colonorum.*
Longest spines about ear and on sides of neck hardly more than half the diameter of the ear-opening. 80 or 90 scales round mid-body. Head longer than broad. Dorsal scales nearly smooth or very feebly keeled, not mucronate .... *elgonis.*
Longest spines about ear and on sides of neck nearly equal the diameter of the ear-opening (in type specimen); dorsal scales small, very feebly and obtusely keeled; throat scarlet in ♂♂ .... *lionotus.*
Longest spines about ear and on sides of neck not nearly equal to, but about one-fifth the diameter of the ear-opening; dorsal scales small, obtusely but strongly keeled:
(i.) Throat scarlet with bright blue border in ♂♂. *lionotus*, var. *dodomæ.*
(ii.) Snout to mid-body including throat bright metallic pink in ♂♂ .... *lionotus*, var. *mwanzæ.*

Longest spines about ear and on sides of neck three-quarters the diameter of the ear-opening; dorsal scales small, very feebly and obtusely keeled, ventrals smooth. Faint nuchal crest; caudal scales very large and strongly spinose .... *flavicauda.*

b. No nuchal crest. Longest of the long spines about ear and on sides of neck equal the diameter of the ear-opening; dorsal scales very large, mucronate, imbricate with strong keels .... *vaillanti.*

11. Occipital scale not enlarged; caudal scales forming more or less distinct annuli; ventral scales smooth; digits compressed.

Slight nuchal crest; caudal scales large, strongly keeled . *atricollis.*

1. AGAMA HISPIDA Linn.
Blgr. Cat. Liz. i. p. 349.
Tanganyika Territory.

2. AGAMA HISPIDA, var. DISTANTI Blgr.
Blgr. Ann. & Mag. N. H. (7) ix. p. 339, 1902.
Uganda; Tanganyika Territory.

3. AGAMA MOSSAMBICA Peters.
Blgr. Cat. Liz. i. p. 353.
Tanganyika Territory.

(3 *a.* AGAMA KIRKII Blgr.
Blgr. Cat. Liz. i. p. 384.
Possibly occurs in Tanganyika Territory.)

4. AGAMA DORIÆ Blgr.
Blgr. Ann. Mus. Civ. st. nat. Genova, ser. 2, ii. p. 127, 1885.
Kenya Colony; Tanganyika Territory.

5. AGAMA PLANICEPS Peters.
Blgr. Cat. Liz. i. p. 358.
Tanganyika Territory.

6. AGAMA COLONORUM Daud.
Blgr. Cat. Liz. i. p. 356.
Uganda; Kenya Colony; Tanganyika Territory.

7. AGAMA ELGONIS Lönnb.
Lönnb. Arkiv för Zoologi, Band 14, no. 12, 1922.
Kenya Colony.

8. AGAMA LIONOTUS Blgr.
Blgr. Proc. Zool. Soc. 1896, p. 214, pl. viii.
Kenya Colony; Tanganyika Territory.

9. Agama lionotus, var. dodomæ Loveridge.
Love. Proc. Zool. Soc. 1923, p. 944.
Tanganyika Territory.

10. Agama lionotus, var. mwanzæ Loveridge.
Love. Proc. Zool. Soc. 1923, p. 945.
Tanganyika Territory.

11. Agama vaillanti Blgr.
Blgr. Ann. Mus. Civ. st. nat. Genova, ser. 2, xv. p. 12, 1895.
Kenya Colony; Tanganyika Territory.

12. Agama flavicauda Wern.
Wern. Zool. Anz. xx. p. 264, 1897.
A. caudospina Meek, Field Mus. Nat. Hist. Pub. 147, p. 407, 1910.
Kenya Colony.

13. Agama atricollis Smith.
Blgr. Cat. Liz. i. p. 358.
Uganda; Kenya Colony; Tanganyika Territory.

2. Aporoscelis.

Blgr. Cat. Liz. i. p. 410.

1. Aporoscelis princeps O'Shaughn.
Blgr. Cat. Liz. i. p. 410.
Zanzibar.

Family Zonuridæ.

Two genera.

I. Limbs well developed; caudal whorls very spinous.................. *Zonurus.*
II. Limbs rudimentary; body serpentiform .... *Chamæsaura.*

1. Zonurus.

Merr. Tent. Syst. Amph. p. 57; Blgr. Cat. Liz. ii. p. 252.

1. Zonurus tropidosternum Cope.
Blgr. Cat. Liz. ii. p. 254.
Tanganyika Territory.

2. Chamæsaura.

Chamæsaura, part, Schneid. Hist. Amph. p. 204; Blgr. Cat. Liz. ii. p. 263.

Synopsis of the Species.

I. Both pairs of limbs very distinct; 24 scales round the body.
Hind limb didactyle .... *annectans.*
Hind limb monodactyle.......... *tenuior.*

II. Fore limbs reduced to minute clawed vestiges; 26 scales round the body .... *miopropus.*

1. CHAMÆSAURA ANNECTANS Blgr.
Blgr. Proc. Zool. Soc. 1899, p. 97.
Uganda; Kenya Colony.

2. CHAMÆSAURA TENUIOR Gthr.
Gthr. Ann. & Mag. N. H. ser. 6, xv. p. 524, 1895.
Uganda; Tanganyika Territory.

3. CHAMÆSAURA MIOPROPUS Blgr.
Blgr. Proc. Zool. Soc. 1894, p. 732.
Tanganyika Territory.

Family VARANIDÆ.

One genus.

1. VARANUS.

Merrem, Tent. Syst. Amph. p. 58; Blgr. Cat. Liz. ii. p. 304.

Synopsis of the Species.

I. Nostril an oblique slit, three times more distant from the end of the snout than from the orbit.
Scales small; nuchals not larger than the occipitals .... *albigularis.*
Scales large; nuchals larger than the occipitals .... *ocellatus.*

II. Nostril round, a little nearer the orbit than the end of the snout . *niloticus.*

1. VARANUS ALBIGULARIS Daud.
Blgr. Cat. Liz. ii. p. 307.
Kenya Colony; Tanganyika Territory; Zanzibar.

2. VARANUS OCELLATUS Rüpp.
Blgr. Cat. Liz. ii. p. 308.
Kenya Colony; Tanganyika Territory.

3. VARANUS NILOTICUS Linn.
Blgr. Cat. Liz. ii. p. 317.
Uganda; Kenya Colony; Tanganyika Territory; Zanzibar.

Family Amphisbænidæ.

Four genera.

I. Segments of the pectoral region not differentiated.

4 labials, third largest .... *Amphisbæna.*
2 labials, first largest .... *Amphisbænula.*
4 shields bordering mouth, first (formed by fusion of labial and nasal, and præfrontal and ocular) largest .... *Chirindia.*

II. Segments of the pectoral region slightly enlarged, forming an angular series.

3 labials, first very small .... *Geocalamus.*

1. Amphisbæna.

Linn. Syst. Nat. i. p. 392, et omn. auct.; Blgr. Cat. Liz. ii. p. 435.

1. Amphisbæna phylofiniens Torn.
Torn. Zool. Anz. 1899, p. 260.
Tanganyika Territory.

2. Amphisbænula.

? Sternf. S.B. Ges. naturf. Berlin, 1911, p. 246.

1. Amphisbænula orientalis Sternf.
Sternf. S.B. Ges. naturf. Berlin, 1911, p. 246.
Tanganyika Territory.

3. Chirindia.

Blgr. Ann. Mag. N. H. (7) xx. p. 48, 1907.

1. Chirindia ewerbecki Wern.
Wern. Hamb. Jahrb. wiss. Anst. xxvii. p. 37, 1910.

4. Geocalamus.

Günth. Ann. & Mag. N. H. (5) vi. p. 234, 1880; Blgr. Cat. Liz. ii. p. 453.

Synopsis of the Species.

2 lower labials; 2 temporals: 38 to 42 segments round body ...... *acutus.*
3 lower labials; 3 temporals; 34 to 38 segments round body......... *modestus.*

1. Geocalamus acutus Sternf.
Sternf. Ergebn. Deut.-Zentral-Afrika Exp. 1907–08, iv. (Z. 2), p. 209, 1912.
Kenya Colony; Tanganyika Territory.

2. Geocalamus modestus Gthr.
Blgr. Cat. Liz. ii. p. 453.
Tanganyika Territory.

Family Lacertidæ.

I. Ventral plates smooth.
  A. Sub-digital lamellæ smooth or tubercular.
    1. Dorsal scales small, juxtaposed or subimbricate.
      Nostril pierced between 2 or 3 nasals, separated from first upper labial; cheeks swollen .... *Nucras.*
      Nostril pierced between 3 or 4 nasals, well separated from the first upper labial; cheeks not swollen ...... *Eremias.*
      Nostril pierced between 2 or 3 nasal and the first upper labial.. *Lacerta.*
    2. Dorsal scales large, imbricate, strongly keeled .... *Algiroides.*
    3. Two series of large smooth plate-like scales along the back and tail .... *Holaspis.*
  B. Subdigital lamellæ keeled.
      Nostril pierced between 3 to 5 nasals and the upper labial, or separated from the latter by a narrow rim . *Latastia.*
      Nostril pierced between 2 or 3 nasals .... *Ichnotropis.*
II. Ventral plates keeled .... *Gastropholis.*

1. Nucras.

Gray, Ann. & Mag. N.H. i. 1838, p. 280; Blgr. Cat. Liz. iii. p. 52.

Synopsis of the Species.

I. Dorsal scales keeled .... *kilosæ.*
II. Dorsal scales smooth.
  Head 4 to 5 times in length to vent; foot as long as or a little longer than the head; parietal foramen present; 40 to 51 scales across the middle of body; ventrals in 28 to 33 transverse series; transversely enlarged plates under the fore-arm ... *emini.*
  Head $4\frac{1}{2}$ to 5 times in length to vent; foot shorter than the head; 45 to 53 scales across middle of body; ventrals in 27 to 34 transverse series .... *boulengeri.*

1. Nucras kilosæ Loveridge.
   Love. Proc. Zool. Soc. 1922, p. 314.
   Tanganyika Territory.

2. Nucras emini Blgr.
   Blgr. Ann. & Mag. N. H. (7) xix. p. 593, 1907.
   Kenya Colony; Tanganyika Territory.

3. Nucras boulengeri O. Neum.
   Neum. Ann. & Mag. N. H. (7) v. p. 56, 1900
   Kenya Colony; Tanganyika Territory.

2. Lacerta.

Lacerta, part., Linn. S. N. i. p. 359.
Lacerta Blgr. Cat. Liz. iii. p. 8.

Synopsis of the Species.

I. Transverse series of ventral plates with notches between the plates; collar serrated; a single postnasal (exceptionally 2); femoral pores 7 to 10	*vaueresselli.*
II. Transverse series of ventral plates with rectilinear or nearly rectilinear border, longitudinal series 6 or 8 in number; femoral pores 12 to 31; 22 to 26 lamellæ under fourth toe.	*jacksoni.*
Parietals usually not in contact (or very narrowly) with upper postocular; temple covered with small scales, as large as or smaller than dorsals	*j. jacksoni.*
Parietals more extensively in contact with upper postocular; temple scales larger than dorsals.................	*j. kibonotensis.*

1. Lacerta vaueresselli Torn.

Torn. Zool. Anz. xxv. p. 701, 1902.

Tanganyika Territory.

2. Lacerta jacksoni Blgr.

Blgr. Proc. Zool. Soc. 1899, p. 96, pl. x.

Uganda; Kenya Colony.

2a. Lacerta jacksoni, var. kibonotensis Lönnb.

Lönnb. Sjöstedt, Kilim.-Meru Exped., Rept. Batr. p. 5, 1907.

Tanganyika Territory.

3. Algiroides.

Bibron, in Bory de St. Vinc. Expéd. Sc. Morée, Rept. p. 67; Blgr. Cat. Liz. iii. p. 43.

Synopsis of the Species.

I. A series of granules between the supraoculars and the supraciliaries; dorsal scales strongly keeled.	
18 to 24 scales across middle of body; 12 to 17 femoral pores on each side; 17 to 19 lamellar scales under the fourth toe; hind limb reaching collar or ear-opening	*africanus.*
33 scales across middle of body; 9 femoral pores on each side; 24 lamellar scales under the fourth toe; hind limb barely reaches shoulder	*boulengeri*
II. Supraoculars in contact with the supraciliaries; dorsal scales feebly keeled; the laterals and anterior dorsals entirely smooth.	*alleni.*

1. Algiroides africanus Blgr.

Blgr. Proc. Zool. Soc. 1906, ii. p. 570.

Uganda.

2. Algiroides boulengeri Peracca.

Perac. Atti Acc. Torin. lii. p. 531, 1917.

Uganda.

3. ALGIROIDES ALLENI Barbour.

Barb. Proc. New Engl. Zool. Club, iv. p. 97, 1914.

Kenya Colony.

4. LATASTIA.

Bedriaga, Ann. Mus. Civ. st. nat. Genova, xx. p. 307, 1884; Blgr. Cat. Liz. iii. p. 54.

Synopsis of the Species.

I. 39 to 52 scales across the middle of the body; no group of small plates in the middle of the pectoral region. Dorsal scales sharply keeled, sometimes doubtfully so in *L. johnstoni.*

No gular fold; edge of collar serrated; 13 to 16 femoral pores on each side .... *johnstoni.*

A gular fold; edge of collar even; 10 to 14 femoral pores on each side .... *siebenrocki.*

II. 52 to 80 scales across the middle of the body, usually 55 to 65, more or less strongly keeled; a group of small irregular plates usually present in the middle of the pectoral region; 5 to 16 femoral pores on each side. Dorsal scales not sharply keeled . *longicaudata.*

1. LATASTIA JOHNSTONI Blgr.

Blgr. Ann. & Mag. N. H. (7) xix. p. 392, 1907.

Tanganyika Territory.

2. LATASTIA SIEBENROCKI Torn.

Eremias siebenrocki Torn. Zool. Jahrb. Syst. xxii. p. 386, 1905.

Kenya Colony; Tanganyika Territory.

3. LATASTIA LONGICAUDATA Reuss.

Blgr. Cat. Liz. iii. p. 55.

Kenya Colony; Tanganyika Territory.

(The East African *longicaudata* may all prove to be of the var. *revoili* Vaill., *vide* Blgr. Monogr. Lacert. ii. p. 30, 1921.)

5. GASTROPHOLIS.

Fischer, Abh. Naturw. Ver. Hamb. (ix.) i. p. 1, 1886; Blgr. Cat. Liz. iii. p. 7.

1. GASTROPHOLIS VITTATA J. G. Fisch.

Blgr. Cat. Liz. iii. p. 7.

G. lutzei Torn. Zool. Jahrb. Syst. xiii. p. 591, fig., 1900.

G. prasina Wern. Zool. Anz. xxvii. p. 462, 1904.

Tanganyika Territory; Zanzibar.

6. ICHNOTROPIS.

Peters, Mon. Berl. Ac. 1854, p. 617; Blgr. Cat. Liz. iii. p. 78.

Synopsis of the Species.

I. Frontonasal single; subocular bordering mouth .... *tanganicana.*

II. Frontonasal longitudinally divided; subocular not bordering the mouth .... *squamulosa.*

1. Ichnotropis tanganicana Blgr.

Blgr. Ann. & Mag. N. H. (8) xix. p. 278, 1917.

Tanganyika Territory.

2. Ichnotropis squamulosa Peters.

Blgr. Cat. Liz. iii. p. 79.

Tanganyika Territory.

7. Eremias.

(Fitzing.) Wiegm. Herp. Mex. p. 9, 1834; Blgr. Cat. Liz. iii. p. 80.

Synopsis of the Species.

I. Toes not or but feebly compressed, with bi- or tricarinate lamellæ inferiorly; 60 to 77 keeled scales across middle of body.

18 to 20 femoral pores on each side; upper head-shields striated ... *spekii.*

II. Toes strongly compressed, with unicarinate lamellæ inferiorly.

68 to 82 smooth scales across middle of body; 17 to 23 femoral pores on each side; upper caudal scales strongly keeled; upper head-shields rugose .... *smithii.*

53 to 68 keeled scales across middle of body; 13 to 18 femoral pores on each side; upper head-shields coarsely striated; subocular bordering the mouth .... *striata.*

53 to 68 keeled scales across middle of body; 20 to 24 femoral pores on each side; upper head-shields finely striated; subocular not reaching the mouth .... *brenneri.*

1. Eremias spekii Gthr.

Blgr. Cat. Liz. iii. p. 84.

E. sextæniata Stejneg. Proc. U.S. Nat. Mus. xvi. p. 718, 1894.

Uganda; Kenya Colony; Tanganyika Territory.

2. Eremias smithii Blgr.

Blgr. Proc. Zool. Soc. 1895, p. 534, pl. xxix. fig. 4.

Kenya Colony.

3. Eremias striata Peters.

Blgr. Cat. Liz. iii. p. 86 (as *E. brenneri*, var. *striata*).

Kenya Colony.

4. Eremias brenneri Peters.

Blgr. Cat. Liz. iii. p. 86.

Kenya Colony.

8. HOLASPIS.

Holaspis (Smith) Gray, Proc. Zool. Soc. 1863, p. 152; Blgr. Cat. Liz. iii. p. 118.

1. HOLASPIS GUENTHERI Gray.
Blgr. Cat. Liz. iii. p. 118.
Uganda; Kenya Colony; Tanganyika Territory.

Family GERRHOSAURIDÆ.

One genus.

1. GERRHOSAURUS.

Ptychopleura, part., Wiegm. Herp. Mex. 1834: Blgr. Cat. Liz. iii. p. 119.

Synopsis of the Species.

I. Tympanic shield small; ventrals in 10 rows .... *major*
II. Tympanic shield narrow; ventrals in 8 rows; laterals smooth .... *flavigularis.*
III. An intermediate form with keeled laterals based on single individual .... *f.* forma *intermedia.*
IV. Tympanic shield narrow; ventrals in 8 rows; laterals keeled .... *nigrolineatus.*

1. GERRHOSAURUS MAJOR A. Dum.
Blgr. Cat. Liz. iii. p. 121.
Kenya Colony; Tanganyika Territory; Zanzibar.

2. GERRHOSAURUS FLAVIGULARIS FLAVIGULARIS Wiegm.
Blgr. Cat. Liz. iii. p. 122.
Kenya Colony; Tanganyika Territory; Zanzibar.

3. GERRHOSAURUS FLAVIGULARIS, forma INTERMEDIA Lönnb.
Lönnb. Sjöstedt, Kilimanjaro-Meru Exp., Rept. Batr. p. 7, 1907.
Tanganyika Territory.

4. GERRHOSAURUS NIGROLINEATUS Hallow.
Blgr. Cat. Liz. iii. p. 122.
Kenya Colony; Tanganyika Territory.

Family SCINCIDÆ.

Seven genera.

I. Nostril pierced in the nasal, or between nasal and supra- or postnasal or first upper labial, not touching the rostral.
A. Pterygoid bones separated on the median line of the palate, the palatal notch extending anteriorly to an imaginary line connecting the centre of the eyes. Supranasals present ... *Mabuia.*

B. Pterygoids in contact (at least quite anteriorly) mesially, the palatal notch not extending anteriorly to between the centre of the eyes.

Eyelids movable; digits, if present, with non-retractile claws .... *Lygosoma.*

Eyelids immovable, transparent, covering the eye .... *Ablepharus.*

II. Nostril pierced in the posterior border of the rostral, or between a nasal or a labial and the rostral.

A. Palatine bones in contact on the median line; nostril pierced between the rostral and a very small nasal, which may be reduced to a narrow ring .... *Scelotes.*

B. Palatine bones separated on the median line; supranasals present; the first upper labial entering nostril.

1. Nostril pierced between the rostral, the supranasal, the postnasal, and the first labial; no frontoparietals *Sepsina.*

2. Nostril pierced between the rostral and the first labial. *Melanoseps.*

III. Nostril pierced in the very large rostral, with the posterior border of which it is connected by a horizontal suture.

Lower eyelid scaly.. *Scolecoseps.*

Lower eyelid transparent........ .... *Acontias.*

1. Mabuia.

Mabuya, part., Fitzing. N. Classif. Rept. p. 23; Blgr. Cat. Liz. iii. p. 150.

Synopsis of the Species.

1. Scales on the soles not spinose.

A. The subocular is distinguished from the (other) labials only by size and position, and is not or scarcely narrowed inferiorly.

a. All the dorsal scales with four or more keels.

4 to 7 keels on dorsal scales; 34 to 36 scales round mid-body; 5 or 6 supraciliaries .... *comorensis.*

7 keels on dorsal scales; 30 to 32 scales round mid-body; 4 to 5 supraciliaries.. *maculilabris.*

7 to 9 keels on dorsal scales; 30 to 32 scales round mid-body; 4 supraciliaries .... *boulengeri.*

b. Most of the dorsal scales tricarinate (*planifrons* with 5 keels on some scales).

30 to 32 scales round mid-body; ear-opening with 2 or 3 short obtuse lobules anteriorly. Præfrontals forming a short median suture .... *brevicollis.*

28 to 32 scales round mid-body; ear-opening with 2 or 4 projecting lobules anteriorly. Præfrontals separated by truncated end of frontal, in contact with fronto-nasal .... *planifrons.*

28 to 32 scales round mid-body; ear-opening with 2 or 3 long, pointed lobules anteriorly. Parietals forming a suture behind interparietal................................ *homalocephala.*

29 scales round mid-body; ear-opening partly concealed under the rounded scales of its anterior border .... *taitana.*

c. Dorsal scales bicarinate or tricarinate; 30 to 32 scales round mid-body; ear-opening with 2 to 4 short, obtuse lobules anteriorly .... *quinquetæniata.*

d. Dorsal scales smooth; 24 to 26 scales round mid-body; ear-opening overlapped anteriorly by one or more scales .... *megalura.*

B. The subocular much narrowed inferiorly, sometimes not reaching the lip; 30 to 34 scales round mid-body; ear-opening with 3 to 5 long, pointed lobules anteriorly. *bayonii.*

II. Scales on the soles spinose and sharply keeled.

30 to 36 scales round mid-body; dorsals tricarinate; subocular largely bordering the lip. Frontoparietals distinct or sometimes fused in one	*varia.*
36 scales round mid-body; dorsals bicarinate; subocular reaches the lip but is much narrowed inferiorly	*brauni.*
32 to 36 scales round mid-body; dorsals tricarinate; hind limb reaching elbow in male and wrist in female.	*obsti.*
32 to 38 scales round mid-body; dorsals mostly tricarinate, sometimes many quinquecarinate; subocular, if reaching lip, much narrowed inferiorly	*striata.*
34 scales round mid-body; dorsals tricarinate; subocular not reaching lip; frontonasal broken up into 3 shields	*irregularis.*

1. MABUIA COMORENSIS Peters.
Blgr. Cat. Liz. iii. p. 163.
Kenya Colony; Tanganyika Territory; Zanzibar.

2. MABUIA MACULILABRIS Gray.
Blgr. Cat. Liz. iii. p. 164.
Uganda; Tanganyika Territory.

3. MABUIA BOULENGERI Sternf.
Sternf. S.B. Ges. naturf. Berlin, 1911, p. 248.
Tanganyika Territory.

4. MABUIA PLANIFRONS Peters.
Blgr. Cat. Liz. iii. p. 167.
Mabuia diesneri Sternf. S.B. Ges. naturf. Berlin, 1911, p. 248.
Kenya Colony; Tanganyika Territory.

5. MABUIA BREVICOLLIS Wiegm.
Blgr. Cat. Liz. iii. p. 169.
Kenya Colony; Tanganyika Territory.

6. MABUIA HOMALOCEPHALA Wiegm.
Blgr. Cat. Liz. iii. p. 170.
(Specimen in Museum of E. A. & U. Nat. Hist. Soc. without loc.)

7. MABUIA TAITANA Peters.
Blgr. Cat. Liz. iii. p. 171.
Kenya Colony.

8. MABUIA QUINQUETÆNIATA Licht.
Blgr. Cat. Liz. iii. p. 198.
Uganda; Kenya Colony; Tanganyika Territory; Zanzibar.

9. Mabuia megalura Peters.
Blgr. Cat. Liz. iii. p. 195.
Uganda; Kenya Colony; Tanganyika Territory.

10. Mabuia bayonii Bocage.
Blgr. Cat. Liz, iii. p. 201.
Kenya Colony; Tanganyika Territory.

11. Mabuia varia Peters.
Blgr. Cat. Liz. iii. p. 202.
M. isselii Peters in Blgr. Cat. Liz. iii. p. 201.
M. hildebrandtii Peters in Blgr. Cat. Liz. iii. p. 207.
Kenya Colony; Tanganyika Territory.

12. Mabuia brauni Torn.
Torn. Zool. Jahrb. Syst. xv. p. 585, 1901–02.
Tanganyika Territory.

13. Mabuia obsti Wern.
Wern. Mitt. Nat. Mus. Hamb. xxx. p. 43, 1913.
Tanganyika Territory.

14. Mabuia striata Peters.
Blgr. Cat. Liz. iii. p. 204.
Uganda; Kenya Colony; Tanganyika Territory; Zanzibar.

15. Mabuia irregularis Lönnb.
Lönnb. Arkiv för Zoologi, Band 14, no. 12, 1922.
Kenya Colony.

2. Lygosoma.

Mabuya, part., Fitzing. N. Classif. Rept. p. 23; Blgr. Cat. Liz. iii. p. 209.

Synopsis of the Species.

I. Limbs well developed; the length of the hind limb exceeds the distance between the centre of the eye and the fore limb. Tympanum distinct. No supranasals. Rostral forming a suture with the frontonasal. One or more pairs of enlarged nuchals. (*Liolepisma* D. & B.)
- Frontoparietals much larger than the interparietal .... *clathrotis.*
- Frontoparietals subequal or smaller than the interparietal... *kutuensis.*

II. Limbs short or rudimentary (except *fernandi*). Ear distinguishable. Supranasals present (or the nasal partially divided longitudinally and forming a suture with its fellow). Præfrontals well developed. (*Riopa* Gray, p. 220.)

A. Limbs pentadactyle.
- 32 to 36 scales round the body; scales feebly tri- or quinquecarinate.. *fernandi.*
- 26 to 28 scales round the body; smooth or feebly tri- or quinquecarinate: 4th toe equal to or a little longer than the 3rd .... *sundevallii.*
- 26 scales round the body; smooth; 4th toe much longer than 3rd .... *ferrandii.*

B. Limbs two-toed. Body elongate, serpentiform.................. *anchietæ.*

III. Limbs more or less developed. Ear covered with scales or very minute. No supranasals. Præfrontals (in the species with short limbs) minute or absent. (*Siaphos* Gray.)

A. Limbs pentadactyle.

13 to 15 infradigital lamellæ; 24 scales round body; ear-opening much larger than the nostril .... *kilimensis.*

12 infradigital lamellæ; 24 scales round the body; ear-opening not much larger than the nostril .... *thomasi.*

14 infradigital lamellæ; 22 scales round body; ear-opening not much larger than the nostril .... *aloysii-sabaudiæ.*

B. Digits 5 or 4. Toes 5–5.

9 to 11 infradigital lamellæ under 4th toe.

22 to 24 scales round body; ear-opening minute .... *graueri.*

Digits with 5 fingers .... *graueri quinquedigitata.*

Digits with 4 fingers .... *graueri quattuordigitata.*

C. Digits 4–4. 12 infradigital lamellæ in longest; 22 scales round the body; ear-opening not much larger than the nostril .... *meleagris.*

D. Digits 3–3. 22 scales round the body; ear-opening much larger than the nostril .... *blochmanni.*

1. Lygosoma clathrotis Blgr.

Blgr. Ann. & Mag. N. H. (7) vi. p. 194, 1900.
Kenya Colony.

2. Lygosoma kutuensis Lönnb.

Lönnb. K. Sv. Vet.-Akad. Handl. Band 47, no. 6, 1911.
Kenya Colony.

3. Lygosoma fernandi Burton.

Blgr. Cat. Liz. iii. p. 304.
Uganda; Kenya Colony.

4. Lygosoma sundevallii Smith.

Blgr. Cat. Liz. iii. p. 307.
L. læviceps Peters, Mon. Berl. Ac. 1874, p. 371, pl. fig. 3.
L. modestum Gthr. Ann. & Mag. N. H. (5) vi. p. 235, 1880.
Uganda; Kenya Colony; Tanganyika Territory; Zanzibar.

5. Lygosoma ferrandii Blgr.

Blgr. Ann. Mus. Civ. st. nat. Genova, (2) xviii. p. 718, pl. 9, fig. 2, 1898.
Tanganyika Territory.

6. Lygosoma anchietæ Bocage.

Blgr. Cat. Liz. iii. p. 316.
Kenya Colony; Tanganyika Territory.

7. Lygosoma kilimensis Stejn.

Stejn. Proc. U.S. Nat. Mus. xiv. (no. 862), p. 405, 1892.
Kenya Colony; Tanganyika Territory.

8. LYGOSOMA THOMASI Torn.
Torn. Zool. Jahrb. Syst. xix. p. 175, 1903.
Kenya Colony.

9. LYGOSOMA ALOYSII-SABANDIÆ Peracca.
Perac. Boll. Mus. Zool. Tor. xxii. (no. 553), 1907.
Uganda.

10. LYGOSOMA GRAUERI QUINQUEDIGITATA Sternf.
Sternf. Ergebn. Deut.-Zentral-Afrika Exp. 1907–08, iv. (Z. 2) p. 241, fig. 3 *b*, 1913.
Tanganyika Territory (?).

11. LYGOSOMA GRAUERI QUATTUORDIGITATA Sternf.
Sternf. Ergebn. Deut.-Zentral-Afrika Exp. 1907–08, iv. (Z. 2) p. 242, fig. 3 *a*, 1913.
Tanganyika Territory.

12. LYGOSOMA MELEAGRIS Blgr.
Blgr. Ann. & Mag. N. H. (7) xix. p. 488, 1907.
Uganda.

13. LYGOSOMA BLOCHMANNI Torn.
Torn. Zool. Jahrb. Syst. xix. p. 173, 1903.
Tanganyika Territory.

3. ABLEPHARUS.

Fitz. Verh. Ges. Naturf. Fr. i. p. 297, 1824; Blgr. Cat. Liz. iii. p. 344.

Synopsis of the Species.

I. Frontoparietal and interparietal united into a single shield.
- 26, rarely 24 or 28 scales round mid-body .... *boutonii.*
- 22 or 24, rarely 26 scales round mid-body .... *boutonii* var. [*peronii.*

II. Frontoparietal single, interparietal distinct.
- 24 scales round mid-body; tail as long as head and body . *wahlbergii.*
- 20 scales round mid-body; tail nearly three times the length of head and body .... *megalurus.*

1. ABLEPHARUS BOUTONII Desj.
Blgr. Cat. Liz. iii. p. 346.
Tanganyika Territory; Zanzibar.

2. ABLEPHARUS BOUTONII, var. PERONII Coct.
Blgr. Cat. Liz. iii. p. 347.
Kenya Colony; Tanganyika Territory.

3. ALBEPHARUS WAHLBERGII Smith.
Blgr. Cat. Liz. iii. p. 350.
Kenya Colony; Tanganyika Territory.

4. ABLEPHARUS MEGALURUS Nieden.
Nied. Mitt. Mus. Berlin, vii. 1913, p. 89.
Tanganyika Territory.

4. SCELOTES.

Fitz. N. Classif. Rept. p. 23; Blgr. Cat. Liz. iii. p. 408.

1. SCELOTES EGGELI Torn.
Torn. Zool. Anz. 1902, p. 700.
Tanganyika Territory.

5. SEPSINA.

Bocage, Jorn. Sc. Lisb. i. p. 62, 1866; Blgr. Cat. Liz. iii. p. 417.

1. SEPSINA TETRADACTYLA Peters.
Blgr. Cat. Liz. iii. p. 420.
Tanganyika Territory.

6. MELANOSEPS.

Blgr. Cat. Liz. iii. p. 422.

1. MELANOSEPS ATER, var. LONGICAUDA Torn.
Torn. Zool. Jahrb. Syst. xiii. p. 602, 1900.
Tanganyika Territory.

7. SCOLECOSEPS.

Loveridge, Proc. Zool. Soc. 1922, p. 159.

1. SCOLECOSEPS ACONTIAS Wern.
Melanoseps acontias Wern. Jahrb. wiss. Anst. xxx. (2) p. 19, 1914.
Tanganyika Territory.

8. ACONTIAS.

Blgr. Cat. Liz. iii. p. 427.

1. ACONTIAS MELEAGRIS Gray.
Blgr. Cat. Liz. iii. p. 427.
Kenya Colony.

Family Anelytropidæ.

One genus.

1. Feylinia.

Gray, Cat. Liz. p. 129, 1845; Blgr. Cat. Liz. iii. p. 431.

1. Feylinia currori Gray.
   Blgr. Cat. Liz. iii. p. 431.
   Uganda; Tanganyika Territory.

42. On some Mammals from Jugoslavia.

By IVOR G. S. MONTAGU, F.Z.S.

[Received August 27, 1923: Read November 6, 1923.]

SYSTEMATIC INDEX.

(Measurements throughout are in millimetres.)

Among the areas least fully inspected in the preparation of G. S. Miller's Catalogue * (1) were those parts of the Balkans now grouped together as Jugoslavia. In consequence of the generosity of Mr. Uvaroff, of Lord Swaythling and Mr. Cotton, material from these regions has recently been added to the British Museum collection. The former made possible the purchase of a part of the collection formed by V. Martino in Croatia, Montenegro, and Serbia; the latter made possible a small scale expedition to Slovenia and Croatia, undertaken by I. Montagu and W. E. C. Cotton.

In addition to the specimens described here and by V. and E. Martino in (2), and to specimens not of immediate interest, these collections include abundant series of *Apodemus*. No account is given here of these series, since they are all referable to the races *A. s. sylvaticus*, *A. s. dichrurus*, *A. agrarius*, and *A. epimelas*, and do not materially affect existing knowledge of the range of those forms.

The described material gives a number of noteworthy results. It indicates the presence in the Croat highlands of *T. cæca*, of a peculiar dormouse resembling that of southern Italy, and of a remarkable new species of *Evotomys*. An *E. glareolus* of the Croat lowlands, resembling that of the western Alps, is recognized as peculiar, as is also a race of *M. agrestis* from the Slovene Alps. The presence of the northern and western *M. a. arvalis* in the Croat lowlands, and that of the southern and eastern *M. a. levis* in the Slovene and Croat highlands, together with the occurrence of a new form resembling the former in eastern Serbia, throws important light on the distribution of these two subspecies. These circumstances may indicate an overlapping of the ranges of the two forms, but, in the writer's opinion, more probably

* (1) Catalogue of the Mammals of Western Europe. B.M. (N.H), 1912.
(2) Annals and Magazine of Natural History, 9th ser. ix. p. 413, 1922.

reveal the presence of a pocket of *M. a. arvalis* extending along the Slavonian plains.

TALPA CÆCA CÆCA Savi.

Type locality. Italy.

Material examined and Dimensions. Two adults (1 ♂, 1 ♀) collected by Montagu in June 1923 in Kupjak, Croatia.

	HB.	T.	HF.
53. Adult ♂, 25. 6. 23.	112	24	17
60. „ ♀, 28. 6. 23.	122	27·5	17

Description. Both the skulls are typical in all respects except size. The skull dimensions throughout, and the length of the hind feet, while less than those of *T. europæus*, are larger than is usual in *T. cæca*; they afford, indeed, new maxima for the latter form. The mesostyles of $m2$ and $m3$ exhibit in each case the characteristic deeply-notched apex.

The presence of this species in the Croat highlands tends to confirm the view that its range is continuous across the Balkans, extending from northern Italy and Switzerland into Asia Minor.

GLIS GLIS POSTUS, subsp. n.

Type locality. Veliki Dergonel, the Gorski Kotar, Croatia.

Material examined and Dimensions. Three adults (2 ♂, 1 ♀) collected by Montagu and Cotton in July 1923 on Veliki Dergonel.

	HB.	T.	HF.	E.
65. Adult ♂, 2. 7. 23.	181	76[1]	31	19·5
314. „ ♂, 2. 7. 23.	181	171	31·5	21
Type 66. „ ♀, 2. 7. 23.	178	150	32	20

[1] Damaged.

Description. The dorsal skin colour is yellow-grey, slightly darkened by the longer blackish hairs; the tail is essentially concolour with the dorsal fur. The animal in dorsal colour thus differs noticeably from *G. g. glis*, showing no trace of the pinkish-brown tint of that race, and approximates to *G. g. italicus*. The tail of the latter, however, is characteristically darkened by heavy pinkish-brown wash, and is accordingly readily distinguished from that of *G. g. postus*.

The dimensions of hind foot and ear are less than the average dimensions of *G. g. italicus*, but larger than those of *G. g. glis*.

The skulls are in no case complete, but examination of the available fragments indicates robust cheek-teeth and a general large size of the constituent bones, recalling the characteristic properties of *G. g. italicus*.

In view of the parallelism between the dormouse of the Croat highlands and that of southern Italy, it is well to recall that dormice from north Italy and Trieste, localities intermediate in point of space, resemble neither in any way and are exactly typical *G. g. glis*.

EVOTOMYS GLAREOLUS SOBRUS, subsp. n.

Type locality. Rescetari, Nova Gradisca, Croatia.

Material examined and Dimensions. Two adults (♀) collected by Martino in September 1921 in Rescetari.

	HB.	T.	HF.	E.
21.12.1.15. Adult ♀, 13.9.21.	93	43	18	13
Type 21.12.1.16. „ ♀, 13.9.21.	101	46	18	13

Description. The dimensions indicate that this lowland bank-mouse is a small one. The dorsal colour is yet more drab than that of the typically dull skin of *E. g. helveticus.* From this and other forms the present one is readily to be distinguished by the shortness and peculiar coloration of its tail. In both the specimens this appendage is dorsally of a pale dust colour and ventrally a nearly clear white. In all described neighbouring races, *E. g. helveticus* of the western Alps, *E. g. nageri* of the eastern Alps, and *E. gorka* of the nearby highlands, the tail is dorsally a dark, nearly seal, brown and ventrally a distinctly yellow-buff.

The skull of this animal is in no way distinguishable from a typical *E. glareolus* skull of small size, such as that of *E. g. helveticus.* In both specimens the third inner angle of *m* 3 is present.

EVOTOMYS GORKA, sp. n.

Type locality. Zalesina, the Gorski Kotar, Croatia.

Material examined and Dimensions. One adult (♀) collected by Montagu in June 1923 in Zalesina.

	HB.	T.	HF.	E.
Type 61. Adult ♀, 28.6.23.	117	54	19	12·5

Description. This specimen is a peculiar one, differing in its characters of skin and skull no less markedly from *E. glareolus sobrus* of the nearby plains than from previously described and more distant races of *Evotomys.*

The body size and skull length are equal to those of the largest European forms of *Evotomys* (*E. rufocanus*, *E. cæsarius*, *E. glareolus nageri*, and *E. g. hallucalis*). The tail is relatively short.

The fur is dorsally long and shaggy and of a bright rufous colour. The flanks are without the usual grey shade, and in fact are so bright an orange-brown that the dorsal stripe pattern typical of the genus is obscured. The grey colour of the belly is a trifle darker than that characteristic of neighbouring *E. glareolus* forms.

The skull of this specimen, a fully-developed adult, shows a long palate and bullæ of great size. The nasals * are longer and

* The nasal measurements given by Miller for *E. g. nageri* are doubtless overestimates. His dimension 8·0 mm. seems to the writer barely to equal 7·8 mm.

narrower than those of *E. g. nageri*, the diastema is long, and the incisive foramina are of great length. The length of the skull from the condyle to the anterior end of the bulla is 9·25 mm. In the largest specimens of *E. glareolus* this dimension attains only 8·65 mm., and in *E. cæsarius* only 8·6 mm. The enamel pattern of the teeth exactly resembles that of a typical *E. glareolus*, in which the third re-entrant angle on the inner side of *m* 3 is present.

MICROTUS AGRESTIS PUNCTUS, subsp. n.

Type locality. Bled, Slovenia.

Material examined and Dimensions. One young adult (♀) collected by Cotton in June 1923 in Bled.

	HB.	T.	HF.	E.
Type 304. Young adult ♀, 16. 6. 23.	87	37	19	12

Description. The dorsal colour is almost black, relieved on the shoulders and face by a slight tawny peppering. In this respect the animal nearly resembles young specimens of *M. a. levernedii*. In *M. a. levernedii*, however, the flanks shade gradually into the ventral greyish-yellow wash; in the present specimen the flanks are tawny, and readily contrast with the ventral white. The white of the belly, though interrupted here and there by the appearance of the slaty bases of the hairs, shows no trace of yellow. The tail is bicoloured and the feet dark.

Measurements of the reconstructed skull indicate the presence of a long brain-case like that of *M. a. levernedii*. The skull presents a unique character in that the anterior edge of the masseteric plate is inclined forward. The distance from the incisors to the lower anterior corner of the plate is accordingly less than in similarly sized skulls of other forms. The pattern of the teeth is that of typical *M. agrestis*, in which the fourth inner angle of *m*1 is not present.

MICROTUS ARVALIS ARVALIS Pallas.

Type locality. Germany.

Material examined and Dimensions. Seven adults (♀) collected by Martino in August and September 1921 in Nova Gradisca, Croatia.

	HB.	T.	HF.	E.
21.12.1.8. Adult ♀, 17. 8. 21.	100	37	15·5	11
21.12.1.9. „ ♀, 17. 8. 21.	100	35	15	11
21.12.1.10. „ ♀, 17. 8. 21.	104	34·5	15·4	11
21.12.1.11. „ ♀, 17. 8. 21.	100	37	15·8	10·3
21.12.1.12. „ ♀, 12. 9. 21.	97	35	15	11
21.12.1.13. „ ♀, 15. 9. 21.	110	36	16·5	12
21.12.1.14. „ ♀, 16. 9. 21.	104	36	15·5	11·4
Average of seven adults	102·1	35·8	15·5	11·1

Description. The dorsal fur is a lighter shade of yellow than that usually seen in more northerly specimens. The belly colour is white, often with the slaty bases of the ventral hairs readily perceptible; in three specimens there are traces of yellowish wash.

The skulls show the characteristic short brain-case and arc-like zygomas of *M. a. arvalis.*

MICROTUS ARVALIS LEVIS Miller.

Type locality. Rumania.

Material examined and Dimensions. Two young adults (1 ♂, 1 ♀) collected by Montagu and Cotton in June 1923 in Bled, Slovenia. One young adult (♂) collected by Montagu in June 1923 in Kupjak, Croatia.

	HB.	T.	HF.	E.
BLED.				
47. Young adult ♂, 16. 6. 23.	102	29	16	11
305. „ „ ♀, 16. 6. 23.	88	28	14	11
KUPJAK.				
55. Young adult ♂, 26. 6. 23.	99	30	18	12

Description. The dorsal brown coloration of the skins is noticeably bright. In each example, and particularly in No. 47, this brightness is present also on the flanks in such a manner as to form a line of demarcation more definite than is usual in *M. arvalis.* The belly is silvery without yellow wash. The feet are nearly seal-brown.

The skulls of these specimens are those of typical *M. a. levis*, showing the characteristic long brain-case and straight parallel zygomas.

MICROTUS ARVALIS CALYPSUS, subsp. n.

Type locality. Nova Varoš, Serbia.

Material examined and Dimensions. One adult (♂ ?) collected by Martino in June 1921 in Nova Varos.

	HB.	T.	HF.	E.
Type 219. Adult ♂ ?, 13. 6. 21.	101	38	15	11

Description. The dorsal colour is pale yellow, distinctly lighter than that of *M. a. arvalis*, slightly overlaid with grey in a median line. The ventral surface is clear silver. The feet are whitish yellow and the tail bicolour, dorsally seal-brown, ventrally whitish yellow.

The size of the skull and hind feet resembles in its smallness *M. a. arvalis* rather than *M. a. levis.*

The skull shows the remarkable combination of a long brain-case and arc-like zygomas. In other respects it is not peculiar.

Skull dimensions.

T. c. cæca.	1.	2.	3.	4.	5.	6.	7.	8.
53. Adult ♂,	31·7	11·1	15·75	9·45	4·25	20·6	12·0	12·3
60. „ ♀,	31·8	10·85	15·8	9·5	4·25	20·8	12·25	12·5

E. gorka.	1.	2.	9.	10.	11.	12.	13.	6.	7*a*.	8*a*.
Type 61. Adult ♀,	26·65	13·85	4·3	12·2	6·8	7·9	8·2	15·6	6·0	5·7
E. g. sobrus.										
21.12.1.15. Adult ♀,	24·4	13·8	4·1	11·7	6·45	7·15	7·0	15·0	5·6	5·3
Type 21.12.1.16. „ ♀,	23·4	13·1	4·0	11·15	6·3	6·7	6·55	14·0	5·75	5·5

1. Condylobasal length.
2. Zygomatic breadth.
3. Breadth of brain-case.
4. Depth of brain-case.
5. Rostral breadth.
6. Mandible.
7. Maxillary tooth-row (ex. incisors).
7*a*. Maxillary cheek-teeth.
8. Mandibular tooth-row (ex. incisors).
8*a*. Mandibular cheek-teeth.
9. Interorbital constriction.
10. Occipital breadth.
11. Occipital depth.
12. Nasal.
13. Diastema.

43. Notes on East African Snakes, collected 1918–1923.

By Arthur Loveridge, F.E.S., C.M.Z.S.

[Received August 14, 1923: Read November 6, 1923.]

The 221 snakes collected during 1915–1917 have already been dealt with in a paper written in the field during the East Africa Campaign *. The present paper deals with some 290 specimens, of which 286 were collected by the writer or his native collectors during the years 1918–1923. Some few earlier captures are referred to but not included in the figures.

The present collection contains representatives of all the East African families. 34 of the 54 genera, and 57 of the 140 recorded species. These numbers are distributed as follows:—

Family.	*Genera.*	*Species.*	*No. of Specimens.*
Typhlopidæ	1	5	23
Glauconiidæ	1	4	15
Pythonidæ	1	1	8
Colubridæ	28	41	201
Viperidæ	3	6	39
		Total ...	286

Only two new species resulted from this material, viz. *Typhlops excentricus* Procter, and *Geodipsas procteræ* Loveridge, which have been described elsewhere.

The principal localities mentioned in the following pages are:—

Kenya Colony.

Frere Town, Nairobi, Uasin Gishu Plateau.

Tanganyika Territory.

Dar es Salaam District.—Dar es Salaam.
Lushoto District.—Usambara Mtns., Gonja.
Moshi District.—Kahe, Garagua.
Arusha District.—Arusha, Longido Mt.
Morogoro District.—Dakawa, Bagilo, Morogoro, Mkata River, Rudewa, Ilonga, Kimamba Stn., Chanzuru, Tindiga, Kipera, Madazini, Kilosa, Kideti.
Iringa District.—Rumruli.
Dodoma District.—Pwaga, Itende, Mpanira, Ikikuyu, Kidenge, Mpwapwa, Dodoma, Suna, Gwao's.

* Loveridge, "Notes on Snakes in East Africa." Jour. E. A. & U. Nat. Hist. Soc. No. 13, 1918, pp. 315-338.

Kondoa-Irangi District.—Mtali's, Mkalama, Zengeragusu, Usshora, Ulugu.
Tabora District.—Tabora, Izikisia, Luguo.
Mwanza District.—Sanga, Shanwa, Sagayo, Nyambita, Mwanza.
Bukoba District.—Bukoba, Kabare.

Portuguese East Africa.

Lumbo on mainland opposite Mozambique Is.

With six exceptions the identifications were all carried out in East Africa, and I take this opportunity of acknowledging my indebtedness to Dr. G. A. Boulenger and Miss Procter for examining these reptiles and confirming determinations of others. My thanks are also due to Dr. H. A. Baylis and Mr, S. Hirst for determining the parasitic worms and ticks.

As a general rule measurements are not given unless they exceed the maximum given in the Catalogue of Snakes. They are then given in inches, followed by snout to vent and tail measurements in millimetres.

Typhlopidæ.

Typhlops mandensis Stejneger.

Blgr. Cat. Snakes, iii. 1896, p. 587.

A single specimen was dug up in some building operations near Government House, Morogoro (23. ix. 17), and brought to me alive. As the species was described from the Isle of Manda off the Lamu Coast of Kenya Colony by Stejneger as long ago as 1894, and no second specimen has been taken to my knowledge, this new record from the interior of Tanganyika Territory is of considerable interest. It measured 18½ inches (463+7). Sex ♀. Alive it was almost colourless except for a little buff on the belly, whereas Stejneger's specimen was "Uniform pale greenish grey above, pale buff beneath." I am indebted to Dr. Boulenger for making the identification, and the specimen has been given to the British Museum.

Typhlops punctatus Leach.

Blgr. Cat. Snakes, i. 1893, p. 42.

Three specimens from Dar es Salaam and Tindiga.

The former measured 138+2·5 and 130+2 mm., with diameter at mid-body of 4 and 5 mm. respectively, so that the diameter goes into the body length 26 to 35 times. Grey above with or without small black blotches and dorsal stripes following the edges of the scale-rows.

TYPHLOPS DINGA Peters.

Blgr. Cat. Snakes, i. 1893, p. 45.

A specimen measuring $33\frac{7}{8}$ inches (850+10) was caught on 27.xii.22 at Kilosa, having come above ground after the first heavy downpour of the lesser rains. In colour it was almost identical with the figure in Peters' 'Reise nach Mossambique,' but a week later it was a dark metallic silver, doubtless a sign that it was about to cast its skin.

TYPHLOPS MUCRUSO var. HUMBO Peters.

Blgr. Cat. Snakes, i. 1893, p. 46.

Thirteen specimens from Ilonga, Kilosa, Kipera, Madazini, Kidenge, Mpwapwa, and Usshora.

The largest female of these measured $23\frac{1}{2}$ inches (590+5) and a male measured $18\frac{3}{8}$ inches (460+6); it was unearthed by some boys digging a trench at Kilosa on 27.i.21, when I made a note "whitish or flesh-coloured, *eyes completely hidden*." It had 35 mid-body scale-rows, diameter went 36 times into total length and the tail 77 times.

On 18.ii.21, having turned the "colourless Typhlops" out of the earth where I had been keeping it, I was astonished to find that it was now the colour of ordinary Kilosa specimens of var. *humbo* and the *eyes distinct* having taken up pigment. I do not know what the explanation was unless that it had sloughed just before capture and pigmentation was delayed in the new skin, but I am perfectly certain that there was no trace of the eyes on 27.i.21, as I examined it very closely with a lens believing I had something new. As the visibility or otherwise of the eyes is an important key-character this is rather interesting.

The coloration was now as follows:—Black above, marbled or speckled (the specks being sometimes confluent) with pale bluish grey. Beneath, the pale blue is about equal to the black in extent. A young specimen had the pale blue brighter, almost bluish slate. It is the constant colouring of all my specimens from Morogoro, Kilosa, and Mpapua.

The eye in my specimens is partly under the præocular, not as shown by Peters* or figured by Sternfeld† for *T. mucruso.* Both these authors show one scale (præocular) between the ocular and the nasal in *forma typica*, whereas in specimens of var. *humbo* from Tanganyika Territory there are distinctly two. In one young specimen the nasal is in contact with its fellow behind the rostral, and nearly so in the adult mentioned above.

The Usshora specimen was swallowed by a Bird Snake (*T. kirtlandii*) with which it shared the vivarium.

* Peters, Reise Mossamb. iii. p. 95, pl. xiii. fig. 3.
† Sternfeld, Fauna der deutschen Kolonien, Reihe III. Heft 2, p. 12, fig. 8.

Typhlops excentricus Procter.

Procter, Ann. & Mag. N. H. ser. 9, vol. ix. p. 685, June 1922.

As only the type-specimen was taken during the two years I resided at Kilosa it must be decidedly uncommon.

Glauconiidæ.

Glauconia distanti Blgr.

Blgr. Cat. Snakes, i. 1895, p. 62.

As the type-locality of this species is Pretoria it was somewhat of a surprise to find it so far north, but Dr. Boulenger has kindly examined the Morogoro specimens for me. Thirteen specimens in all were taken from Morogoro and Kilosa.

The largest measured 6 inches (139+12), but the largest of six Kilosa snakes was only $3\frac{3}{8}$ inches (78+6).

The tail of the type was included 12 times in the total length, but the range of Kilosa snakes is from 9 to 13 times, one specimen having a body length of 65 mm. had a tail 7 mm. long. The diameter of the body into total length ranges from 48 to 56 as against 65 times in the type. Whilst the type had five lower labials, two Kilosa snakes have four and three others only three!

Glauconia merkeri Werner.

Wern. Jahresh. Ver. Nat. Württemb. lxv. 1909, p. 61,

A single female from Mtali's, Mkalama Dist., where it was found wriggling on the surface of the ground beneath a fig-tree about 9 p.m. on 10. x. 22. The species is, I believe, only known from the types which came from Moshi much farther east.

My specimen is a female and is larger than the type by 52 mm. Length of head and body 212 mm. Length of tail 15 mm. Diameter of body 3·5 mm. The diameter, therefore, goes 64·8 times into the total length as against 80–87 times in the types. The tail goes 14 times as against $11\frac{1}{2}$–$13\frac{1}{2}$ times in the original specimens. It has 4 upper labials.

The colour is uniform blackish, the borders of the scales lighter. Pupil red with a black ring.

Glauconia emini Blgr.

Blgr. Cat. Snakes, i. 1895, p. 64.

A specimen found in a heap of dry manure on the golf links at Dar es Salaam, 4. xii. 22, agrees with Boulenger's description of *G. emini* except in the following points:—

(i.) Flesh-colour. In life, however, semi-transparent, the dorsal scales being minutely stippled with brown, the belly scales quite transparent. A pinkish tinge imparted to the whole by the blood-vessels which can be plainly seen. The type of *G. emini* uniformly blackish, similar to specimens collected by the writer at Nairobi, but there is a specimen from Kosa Kola, Lake Nyasa, in the British Museum, which is also pale tending to orange on the back and has been referred to *G. emini* by Dr. Boulenger.

(ii.) Posterior border of the rostral does not nearly extend to the level of the eyes as against "not extending quite to the level of the eyes." In the Catalogue description the Lake Nyasa specimen is like mine in this respect also.

(iii.) The diameter of the body goes 57 times into the total length as against 50–55 times.

I think there is no doubt, however, that I am correct in referring my specimen to *G. emini*, which has already been recorded from the extreme west of the Territory, the type-locality is Victoria Nyanza. The present record shows that its range extends right to the coast in the east.

Length of head and body 102 mm. Tail 13 mm. Diameter of body 2 mm. The length of tail goes $9\frac{1}{2}$ times into the total length.

GLAUCONIA LONGICAUDA Peters.

Blgr. Cat. Snakes, i. 1895, p. 66.

Four specimens taken at Lumbo, Mozambique.

The longest of these measured $4\frac{3}{4}$ inches (110+12), all were females. This snake is far more slender than an average earthworm and of a very transparent flesh-colour. All were taken among the roots of bushes when some land was being cleared of stumps for a camp site.

One which was brought to me in the early morning was dropped into a cigarette tin containing several *Lycophidium semiannulis* and *Aparallactus capensis* from the same habitat. On opening the tin about 6 p.m. the worm snake was found to be missing, but by holding up the other snakes to a strong acetylene light it was located in the stomach of a Cape Black-headed Snake. It was the work of a few minutes to chloroform the latter, but the worm snake was already too far digested to be worth preserving.

PYTHONIDÆ.

PYTHON SEBÆ Gmel.

Blgr. Cat. Snakes, i. 1893, p. 83.

Eight specimens, Rumruli, Ilonga, Chanzuru, Kilosa, and Usshora.

Three of these were young specimens sent me by Mrs. Billinge of Rumruli, Iringa, who wrote that the natives had killed a female python, whose unstretched skin measured 20 feet, and which had 34 young ones with it. She adds that the natives never attack the pythons unless they have first taken a dog or goat-kid, and to judge by the number of pythons so killed they must do an appreciable amount of damage in the district.

A native youngster coming up from Kilosa village heard an outcry by the roadside which he thought was a young kid. Parting the grass about a bush he saw a large python which was swallowing a reedbuck. He took me to the spot, which was a very likely one, but the python had gone; I think it was more probably a young bushbuck that was taken.

Many parasitic worms were found in the stomachs of my specimens, viz. *Bothridium pythonis* Blainv., *Polydelphis attenuata* Mol., *Ophidascaris filaria* (Duj.), and other indeterminate immature Ascarids. A larval Filarian was also found coiled up in pimples which it causes on the skin. Snakes so affected rapidly lose their glossy and iridescent appearance, refuse to feed, and succumb within a few months. The disease appears to be infectious to the extent that another snake introduced into the same cage, after the removal of the dying snake, became infected.

COLUBRIDÆ.

TROPIDONOTUS OLIVACEUS Peters.

Blgr. Cat. Snakes, i. 1893, p. 227.

Four specimens from Dar es Salaam, Bagilo, and Kabare. Found in swampy grass-lands and along river-banks.

All the specimens were rather small. A Dar es Salaam female, kept in captivity, laid eight eggs measuring 17×8 mm. on 15. vi. 18. A Bagilo specimen killed 22. vii. 21 had three eggs in the ovary measuring 22×6 mm., this was an extremely small specimen measuring 262 mm. in head and body; the tip of the tail was missing, as is often the case with snakes of this species. It would be interesting to know what enemy it is that deprives them of their tails.

Bagilo specimens have the borders of the ventrals bright mauve and not olive.

The Dar es Salaam snake swallowed two frogs (*Rana nutti*), hind-legs first, on 22. vi. 18, and another, head first, on 24. vi. 18.

BOODON LINEATUS Dum. & Bib.

Blgr. Cat. Snakes, i. 1893, p. 332.

Thirteen specimens from Mkata River, Kimamba, Pwaga, Ikikuyu, Gwao's, Sanga, Shanwa, Tabora, and Bukoba.

The House Snake is usually found about the habitations of man, among rubbish in outhouses, under old sacks, or beneath sheets of iron in the open. It is not infrequently met with crossing paths, and when detected doing so it usually remains perfectly motionless until very closely approached. One large specimen on path entered a fissure in black cotton soil and on being dug out disgorged a large rat (*Rattus coucha microdon*).

A bright orange-coloured specimen was met with at Dodoma (I accidentally trod upon it in coming out of my room). I have never met with an orange variety before, and it faded to straw-colour when preserved. Young specimens tend to be rufous and have fine reticulations which disappear in the adult, which is plumbeous in most of the above specimens.

The reason for their frequenting houses is to be found in their almost exclusive diet of rodents. One such specimen had swallowed a rat and was found with a foot of its tail hanging out of a crevice in the stone basework of the house. The snake was so wedged in that the stone masonry had to be removed before the snake could be extricated. A 2 feet 8 inch snake at Gwao's, with greatly distended stomach, held two unstriped grass rats (*Arvicanthis abyssinicus neumanni*) in its stomach.

On a kopje at Tabora I came upon a Striped-bellied Sand Snake swallowing a young House Snake. When I appeared the Sand Snake disgorged its prey, which I put in my pocket, but found it dead on reaching home, presumably killed by the venom of the back-fanged species.

Ticks (*Aponomma læve* Linn.) were found in one Kilosa specimen.

? Lycophidium acutirostre Günth.

Blgr. Cat. Snakes, i. 1893, p. 338.

The day before sailing from Dar es Salaam (25. v. 23) I encountered a snake on the sea-front road by the golf links; it was holding its snout downwards, after the manner of an Atractaspis viper, and pushing against a fragment of coco-nut shell as if seeking shelter beneath it from the sun. The snake showed no sense in pushing round and round the fragment. I confess I mistook it for *A. rostrata*, picked it up by its stumpy tail, dropped it in a bag, and sent it on board.

I did not examine it again until the second day at sea, when I found it not only dead but very decomposed. Close examination showed at once that it was a *Lycophidium*, and according to Boulenger's key * it was *L. acutirostre*, hitherto only known from Zanzibar Is. As I was unable to count the ventrals or compare it with the full description, I have marked the determination with a query. The specimen was too decomposed to preserve.

It seems to me from its striking superficial likeness to *Atractaspis rostrata* that this species of *Lycophidium* has adopted similar burrowing habits, and it may be on this account that it is so rarely met with, less than a dozen specimens being known I believe.

* Boulenger, "A List of the Snakes of East Africa . . . etc." P. Z. S. 1915, p. 620.

Lycophidium semiannulis Peters.

Blgr. Cat. Snakes, i. 1893, p. 339.

Eight specimens were taken at Lumbo, where they lived in the surface soil amongst the roots of grass.

The largest male measured 7¾ inches (170+21) and female 9⅜ inches (203+35). None of the specimens attempted to bite when handled.

Lycophidium capense Smith.

Blgr. Cat. Snakes, i. 1893, p. 339.

Two specimens from Kilosa, found on paths.

The largest specimen I have yet come across was taken at Morogoro, 18⅜ inches (405+52).

A nematode (*Physaloptera* sp.) was taken from a Kilosa snake

Lycophidium jacksonii Blgr.

Blgr. Cat. Snakes, i. 1893, p. 340.

A single specimen was taken in a tent at Longido after a night of heavy rain. The type-locality is Kilimanjaro, so the present record of this rare snake extends our knowledge of its westward distribution somewhat.

It was taken in the act of attempting to swallow a skink (*Lygosoma ferrandii*), which was rather a big mouthful for it.

Simocephalus nyassæ Günth.

Blgr. Cat. Snakes, i. 1893, p. 347.

A single specimen at Lumbo during the demolition of a termite hill. Female 22 inches (433+122).

Chlorophis neglectus Peters.

Blgr. Cat. Snakes, ii. 1894, p. 94.

Five specimens from Nairobi. As a variant from its usual habitat one put its head out of a leather hair-brush case, having reached the dressing table from an open window.

One was seen swallowing a frog—its usual diet—but another had no less than three skinks (*Ablepharus wahlbergii*) in its stomach.

An immature ascarid was also found in one specimen.

Chlorophis irregularis Leach.

Blgr. Cat. Snakes, ii. 1894, p. 96.

Single specimen from Bukoba, collected by Mr. N. C. Miller.

PHILOTHAMNUS SEMIVARIEGATUS Smith.

Blgr. Cat. Snakes, ii. 1894, p. 99.

Twelve specimens from Dar es Salaam, Ilonga, Kimamba, Kilosa, Kabare, and Lumbo.

None of these exceeded in size a female from Morogoro, measuring $51\frac{7}{8}$ inches (837+466), taken 25. xi. 17. One specimen had only 149 ventrals and two had 159 sub-caudals.

The coloration of Lumbo specimens was strikingly different from the grass-green examples, of which a long series were taken previously. In Lumbo specimens the head and neck were pale green; body mauve; both freely speckled with black. The tail was plumbeous; throat china-white; belly and sub-caudals whitish with a mauve tint. Ventral keels of a mauve colour. The tongue at tip and base was black, but the middle portion bright Cambridge-blue. All four specimens taken at Lumbo were the same.

Attracted by the outcry raised by birds, I captured the Frere Town specimen whilst it was descending the almost vertical tree-trunk, taking advantage of every irregularity in the bark.

A Spotted Wood Snake was found swallowing a gecko (*Hemidactylus mabouia*) in the fowl-house and only the tail was to be seen. Immediately it was approached the snake disgorged the gecko, and on being seized by the tail *inflated the neck and anterior portion of the body* vertically, and struck at my hand repeatedly. Here then is another tree-snake with the same habit of inflation when alarmed or annoyed as the Boomslang and Bird Snake.

Another specimen on being caught in a thatch disgorged a gecko of the same species, and a third snake had swallowed a young toad (*Bufo regularis*).

During a flood one specimen was found on a maize stalk, five feet above the water. A young one was recovered from the stomach of a One-streaked Hawk (*Kaupifalco monogrammica*).

THRASOPS ROTHSCHILDI Mocq.

Mocq. Bull. Mus. Paris, 1905, p. 286.

A specimen sent me from Bukoba extends the range of this scarce reptile westwards; it was described from British East Africa. I have also had the pleasure of examining three more specimens collected by Mr. J. A. Turner in the Yala River region near Mt. Elgon.

RHAMNOPHIS JACKSONII Günth.

Blgr. Cat. Snakes, iii. 1896, p. 632.

One male from Kabare.

A specimen of this snake was killed at Muthaiga, near Nairobi, in 1919, by Mr. A. J. Klein, and is now in the Nairobi Museum. It measured 7 feet $5\frac{1}{2}$ inches (1671+584), and eight specimens were collected by Mr. Turner on the Yala River.

I have never seen the resemblance of this snake to the black phase of *Dispholidus typus* remarked upon. Their similarity of appearance is extraordinary and when alive they are indistinguishable, except perhaps for the slightly larger eye of the Boomslang—both are tree-snakes and found in the same locality at times. Like all snakes that are large and black they are indiscriminately called "Black Mambas" by the European residents.

CORONELLA SEMIORNATA Peters.

Blgr. Cat. Snakes, ii. 1894, p. 195.

Two examples from Dar es Salaam and Sagayo, Mwanza.

The latter specimen is very juvenile (210 mm. over all), and has a small scale between the rostral, internasals, and nasals, apparently split off from the rostral.

CORONELLA SCHEFFLERI Sternf.

Sternf. Sitzb. Ges. Nat. Fr. Berl. 1908, p. 93.

I have not been so fortunate as to collect this rare snake myself, but a specimen in the Nairobi Museum was obtained by Capt. Rainsford just south of Lake Rudolph in 1918. This new record is, therefore, far north of the type-locality Kibwezi on the Uganda Railway.

GRAYIA THOLLONI Mocq.

Mocq. Bull. Soc. Philom. (8) ix. 1897, p. 11.

Mr. N. C. Miller sent me a specimen for determination which he had collected at Bukoba, 1922.

HOMALOSOMA LUTRIX Linn.

Blgr. Cat. Snakes, ii. 1894, p. 273.

A single specimen from Kabare, Bukoba, 10. i. 23.

This female, though small (290+38 mm.), was very bloated, having no fewer than ten eggs, measuring 12×8 mm., in its oviduct which extended forward to the region of the heart.

PROSYMNA AMBIGUA Bocage.

Blgr. Cat. Snakes, ii. 1894, p. 248.

Three specimens. One of these was taken in a termite nest at Lumbo; the other two were found in a bottle without data in a German House at Morogoro.

One of these had paired præfrontals and 155 ventral scutes.

DASYPELTIS SCABRA Linn.

Blgr. Cat. Snakes, ii. 1894, p. 354.

Six specimens were collected from Kilosa, Kipera, and Zengeragusu in Tanganyika Territory and Lumbo in Portuguese East Africa.

The Kilosa and Kipera specimens are of the type that appears to be a mimic of *Causus rhombeatus*, but *C. rhombeatus* is not found at Kilosa, and where this Night Adder is common at Nairobi you get an all-black or all-brown variety of the Egg-eater. The Zengeragusu reptile was a most interesting variety. Colour iron-clad grey with a single row of brick-red dorsal spots.

This snake was literally covered with ticks (*Aponomma læve* Linn.), seventy-five of which I collected.

Geodipsas procteræ Loveridge.

Love. Proc. Zool. Soc. 1922, p. 313.

Since my description of the type a second specimen has been taken in the same locality by my collector.

Male. Snout to vent 350 mm. Tail 70 mm. Mid-body scales 17; ventrals 153; caudals 40; upper labials 8. This specimen agrees with the type in all essential respects, excepting that the 3rd, 4th, and 5th upper labials enter the eye as against 4th and 5th in the type. It has also 5 more ventrals and 9 caudals less.

The following markings are also distinguishable. A black collar on nape or back of head touching posterior border of parietals, but not reaching to ventrals; it is very broadly **V**-shaped. Twelve or more black saddle-like markings, two scales deep, on anterior third of body, separated from one another by two-scale intervals which are approximately 2 mm. interspaces. White stipplings on sides of anterior third of body sometimes falling on outer edges of ventrals, which are grey and thus differ from the colouring in the type, as they are very distinct from the blackish dorsal colouring.

Tarbophis semiannulatus Smith.

Blgr. Cat. Snakes, iii. 1896, p. 51.

Five specimens from Morogoro and Lumbo.

The Morogoro specimen is so much larger than the dimensions given in the Catalogue that I give it here—35¼ inches (735 + 159). A Lumbo specimen had only 198 ventrals.

It is curious how one may be in a locality for many months without meeting with a particular species of snake, and then several turn up within a few days, followed by a long period when none are met with. Such was the case with this species at Lumbo, where I caught two females in one evening and a third a few days later, the circumstances of capture being as follows:—At 7 p.m. I was hastily summoned to the Mess, where it appears that the adjutant was about to take his seat when the snake was noticed entwined in the wicker back of the chair. After putting this Tiger Snake into a bag I returned to my tent, and within an hour was summoned to capture a second, which was slowly moving across the arc of illumination cast from a lighted tent. Both were females, and there was only a millimetre difference in their lengths (2 feet 6 inches); they were taken about 200–300 yards apart.

The larger had ten eggs in the ovary, the smaller nine. Both stomachs were empty of food, but the one was afflicted with immature and, therefore, indeterminate worms of the genus *Physaloptera*, as was also a specimen taken a few days later.

Leptodira hotambœia Laur.

Blgr. Cat. Snakes, iii. 1896, p. 89.

Two specimens from Garagua and Mwanza.

The latter had 20 and not 19 scale-rows at mid-body. Instead of the white frecklings usual in East African Herald Snakes it had transverse wavy white lines, one-scale wide, all along the back, which gave it a very Causus-like appearance. When annoyed these Herald Snakes flatten their heads till the white lips can be seen from above; the body is also depressed and flung about spasmodically, giving the reptile a very viperish aspect.

I have always found them vicious and ready to bite on the least provocation; one specimen introduced into a vivarium where there were already a couple of larger snakes (*P. sibilans* and *R. oxyrhynchus*) bit them both, but neither appeared to suffer any ill effects.

Chamætortus aulicus Günth.

Blgr. Cat. Snakes, iii. 1896, p. 98.

I have only come across three specimens of this scarce snake in the past eight years: one was much battered in the roadway at Mwomero, another was found, without data, in a bottle in a German house at Morogoro in 1916, and recently (26. iv. 21) a young one at Chanzuru near Kilosa which had the remains of a gecko (apparently *Lygodactylus* sp.) in its stomach.

Amplorhinus nototænia Günth.

Blgr. Cat. Snakes, iii. 1896, p. 125.

Two specimens. A young male from Kilosa, and a female from Mkata River. The former was crossing open ground, and the latter was twisted into the side of a grass hut, about 6 feet from the ground. In its ovary were two eggs, 12 mm. long (27. viii. 21). In its stomach the remains of a gecko (*Lygodactylus picturatus*), and it was apparently stalking another which was close to it at time of capture.

Trimerorhinus tritæniatus Günth.

Blgr. Cat. Snakes, iii. 1896, p. 139.

Two specimens from Arusha and Nairobi. I take this opportunity of correcting an error of mine when I referred these specimens to *Psammophis brevirostris** Peters. The Nairobi example was taken from beneath a latrine seat!

* Journal E. A. & U. N. H. Soc. No. 13, 1918, p. 320.

A fortnight after its capture it attempted to swallow a dead female *Mabuia striata* which was put into the cage. The skink was much too large for it, but the snake persevered for thirty minutes, but could not get past the front legs; it finally disgorged the whole. The Arusha specimen had a skink in its stomach when taken. This snake is extremely gentle.

RHAMPHIOPHIS OXYRHYNCHUS Reinh.

Blgr. Cat. Snakes, iii. 1896, p. 146.

Eight specimens, Dar es Salaam, Chanzuru, Kilosa, Tindiga, Pwaga, Dodoma, Luguo, and Mwanza District (1920–22), as against twenty-six from Morogoro and Lumbo (1915–18). Several were dug out of gerbil (*T. swaythlingi*) holes and one was found occupying the same hole as a mungoose (*H. ivorii*).

The largest male (whose tail-tip was missing) measured 56¾ inches (1014 + 425), and largest female 5 feet (1040 + 469), nearly six inches longer than the maximum measurement given in the Catalogue. Half-a-dozen specimens had more than 110 subcaudals, the highest number being 116. As might be expected, a specimen from the sandy thornbush country of Dodoma was very pale sand-colour.

At Kilosa these snakes were pairing during December in 1920. Three very large ones were seen many times in the grass during November, the rains having commenced on the 1st, but it was not till the 4th of December that I surprised a pair *in coitu*; one of these I caught, and the other the following day. It was about 5 feet long. Ten eggs measuring 40 × 20 mm. were laid by one of this pair in the vivarium between 1–7. viii. 1921, so that the period of gestation would be about three months. Eight eggs (15 × 8 mm.) in a Dodoma specimen taken 11. vii. 21. I have already recorded 13 eggs laid in October by a half-grown female of this species.

In diet they are omnivorous; a small specimen endeavoured to swallow a large rat, but could not get past the front legs and was forced to disgorge (12. iii. 21), but a large specimen took a young rat (15. 6. 21), and a wild specimen disgorged a shrew (*Crocidura flavescens*) on being caught. The natives say that a tame guinea-fowl chicken was taken by the largest of the three snakes which were seen in September. The chicken was heard calling in the grass, but as the boys were afraid to go into the grass, it is a matter of supposition. In captivity I feed them on *Mabuia varia*, which they take well. It might be of interest to herpetologists to know that a snake should not be fed on recently chloroformed food. Wishing to pack some of these snakes to go to Europe I chloroformed some geckos and skinks and introduced them into the mouths of the snakes, which swallowed them, but a few moments later showed signs of poisoning, one rolling on its back.

The bite of this species would not appear to be dangerous to human beings, as a small native boy who caught a 4-foot snake was much bitten on the hands (which bled freely), but suffered no ill effects. After the first excitement, incidental to capture, they settle down to a life of confinement and are the gentlest of snakes.

I found a young specimen in the stomach of a hawk (*Butastur rufipennis*) at Morogoro on 31. i. 18.

Parasitic worms (*Filaria* sp.) were found encysted in the skin. Ticks (*Aponomma læve* Linn.) were found on a Kilosa snake (20. v. 23).

PSAMMOPHIS SUBTÆNIATUS Peters.

Blgr. Cat. Snakes, iii. 1896, p. 160.

The Stripe-bellied Sand Snake called Sangaraza in Kiswahili is so widely distributed that I have not troubled to catch many this tour, as forty-six were collected in 1915–19; about a score were taken 1920–22 from many fresh localities near Dakawa, Mkindo Mkata Stn., Ilonga, Kimamba, Chanzuru, Kilosa, Itende, Kidoti, Suna, Mtali's, Sekenke Rd., 20 miles from Mkalama, Usshora, Wembere, Tabora, Sanga, Lalago, Sagayo, Nyambita, and Lumbo.

This snake is an expert climber; one flashed across my path and was 20 feet up in the topmost twigs of a stunted tree in a moment. My attention was drawn to another five feet up in a maiombo bush, but so well did it blend with its surroundings that I could not distinguish it until it moved, though I was within ten feet of it all the time. I caught several in the thatches of native huts, where they had gone in search of skinks I believe.

My largest male measured $49\frac{3}{4}$ inches (861 + 399) and female $45\frac{3}{4}$ inches (775 + 383). Both from Morogoro.

Whilst the colouring in specimens from one locality seems constant, a great deal of variation occurs between examples from different localities. The characteristic black ventral lines were indistinguishable, except with the closest examination when traces could be seen, in the Kidete specimen collected by Mr. C. F. M. Swynnerton. Four snakes from Mtali's had pure white instead of deep yellow bellies. At Suna the coloration is adapted to the sandy thornbush in which they live, and which seems to influence the coloration of its typical mammals and, to a less extent, birds.

This species will eat mammals, birds, snakes, and lizards. A specimen taken at Frere Town after a hard chase was placed in an ordinary small biscuit tin, about 8 × 5 inches in size. The following day a native brought me a Warbler (*Prinia mystacea*) with its head almost knocked off, this I dropped into the tin, and on opening it the following day found a bulge in the snake and no visible bird. This freshly-caught diurnal snake had eaten a damaged dead bird in the darkness of a small tin on the day succeeding capture. There is no saying what a snake will do.

The following note was made at Kimamba on 15. viii. 21:

"Between 5.30 p.m. and sundown I saw a Stripe-bellied Sand Snake lying in the roadway; three times I disturbed it and it returned each time. I noticed that a number of the Small Weavers (*Lagonosticta* sp.) were picking up grass seeds and hopping about unconcernedly close to it. I think one might assume that the snake was lying there with the object of securing a bird."

I have already mentioned under *B. lineatus* how one of this species was found swallowing a young House Snake at Tabora.

Their commonest food, however, is the striped skink, and this they very soon dispose of, as the following timing will show:—

12.44.50.	Snake seized skink.
12.47.10.	Head of skink was in throat.
12.48.	Hind-legs enveloped.
12.48.10.	Tail disappears.

There is usually a pause for rest after the body has passed into the gullet, and the tail of the meal sticks out of the snake's mouth as if it had been having an after-dinner cigar!

At Frere Town (1. vii. 19) my attention was drawn to one of these snakes which appeared to be playing. When first seen it was stretched out at full length excepting that its head was turned round in the direction of its tail. It then passed its head beneath its body, then over the back, then beneath the body again, and so on, traversing its own length towards the tail. This was not done hurriedly, but in dallying fashion, with occasional withdrawing of the head. Unfortunately, a native running up at this moment disturbed it, so that I was unable to see the end of the performance.

At Kilosa a captive specimen was seen to rub first one side of its mouth against its side, then the other side of the mouth against the opposite side, repeating the operation a score of times as it slowly worked along its own length to the tail. I feel sure this caressing movement was only play. Having reached the tail it moved slowly away in the grass (Kilosa, 2. v. 23). This snake, nearly 3 feet in length, was killed and three-quarters eaten by a baby lemur (*Galago panganiensis*) occupying the same large roomy cage (Kilosa, 4. v. 23).

At Lumbo camp I often wondered what chance a snake would have of being in the camp without my being informed by one of the hundreds of natives employed about the place. With the object of deciding this I released a Stripe-bellied Sand Snake near my tent. This tent was situated beneath a mango and a coco-nut palm, but had a cleared space of fifty yards of sand on three sides of it, on the fourth side were several buildings. The snake was caught by me on a railway embankment half-a-mile away, escaped, and was recaught by the reed fence enclosing the tent. Next day I liberated it at 6 a.m. At 8.30 a native came running to say a snake was in his tent, which lay a little more than fifty yards to the west of mine, and was the first cover in that direction after crossing the open sand. I recaptured it and a week later released it at 11 a.m. At 1.30 p.m. a European corporal hurried up requesting me to catch a snake which was under his bed; the marquee in which he slept was due north from my tent. A week later I again released it at 6 a.m. and at 8.45 a.m. found a man trying to head it off from entering a patient's marquee, almost due south from my tent and the first cover in that direction. It had now tried in three different directions, which was rather remarkable, and had been apprehended at the first tent in the direction taken. Twice more I liberated it, the last time at 10 p.m., to give it a night's start, and I saw its tail disappear beneath my bed. As I heard nothing more of it for a fortnight I thought it had at last won clear of the camp, but on Oct. 10 it was found at noon in the tent of some A.N.M.C. boys, one of whom struck at it with a stick, so injuring it that I killed it and threw it into a case of Lesser Mungoose (*Helogale ivorii* Thos.), one of which seized it, first crunched its head, and then swallowed it whole. This snake had a portion of its tail missing, so it was unmistakable. I concluded from the results of this little experiment that I made a pretty exhaustive snake survey of the area covered by the camp when I collected sixteen species in it during five months.

Many kinds of worms were found in the stomachs of various specimens, including two new species in a Mombasa snake, viz., *Oochoristica crassiceps* Baylis, and *Ophidascaris mombassica* Baylis. *Physaloptera affinis* Gedoelst, from a Kilosa specimen. *Physaloptera* sp. and *Ascaris* sp. from Mombasa specimens. I am of the opinion that these worms may cause the death of the host, for in two instances the snake turned over and over and died. In the case of the Mombasa snake the feet and claws of the Prinia it had eaten just a month before were still in its stomach.

PSAMMOPHIS SIBILANS Linn.

Blgr. Cat. Snakes, iii. 1896, p. 161.

Nine specimens from Chanzuru, Kilosa, Wembere, and Lumbo

Largest male 58¾ inches (1120 + 362) and largest female 59½ inches (1100+404), but the tail tip is missing. The tail is proportionately longer in the females of this species. Both these records are of Morogoro specimens, being the best of seventeen specimens collected 1917–18.

This snake feeds upon both mammals and reptiles, a very large mouse being taken from the stomach of one snake and several records of geckos (*H. mabouia*) being taken by them.

The eagle in whose gullet a full-grown specimen was found has since been identified as the Black-breasted Harrier Eagle (*Circaëtus pectoralis* Smith). I have since taken a younger snake in the stomach of another species of hawk.

At Lumbo (19. viii. 18) some natives killed a fine Cobra (*N. nigricollis*) in the act of swallowing a large Hissing Sand Snake. The cobra measured 50½ inches and had already swallowed

28 inches of the sand snake whose *body* measured $33\frac{1}{2}$ inches; unfortunately, in the excitement of killing the cobra the greater part of the tail of the sand snake had been cut off, but other specimens of this body length had tails of between 12 and 13 inches, so that a $50\frac{1}{2}$-inch snake was engaged in swallowing a 46 inch snake and would doubtless have succeeded.

From one of these Lumbo snakes I removed three worms (*Polydelphis quadricornis* Wedl.) which measured 14 mm. × 6 mm. A Morogoro specimen, which was ailing and would not feed, spued up a quantity of watery and slimy matter on the morning of 9. iv. 18 and died the same evening. There were no visible parasites in the stomach, but one lobe of the liver appeared to be full of cysts.

When crossing the Wembere Flats (9. xi. 21) I came upon a sand snake at 8 a.m. that was apparently dying of thirst. It offered no resistance to being picked up and died shortly afterwards. The stomach was clean and empty. It had dusky ventral stripes like the brighter ones of *P. subtæniatus*.

Psammophis biseriatus Peters.

Blgr. Cat. Snakes, iii. 1896, p. 168.

Three specimens from Kahe, Ikikuyu, and Dodoma. This species seems partial to sandy or rock-strewn desert country. The Dodoma snake, though only measuring $12\frac{3}{4}$ inches, had a skink (*Lygosoma ferrandii*) in its stomach, as had also the Ikikuyu specimen.

Psammophis angolensis Bocage.

Blgr. Cat. Snakes, iii. 1896, p. 170.

Six specimens from Kilosa and Izikisia, and two which were without locality in a bottle at Morogoro, at which place they were probably taken. Three were taken on paths and one twisted into the grass of a banda five feet from the ground. This last had nine upper labials on the left lip, the right having the normal number of eight.

Thelotornis kirtlandii Hallow.

Blgr. Cat. Snakes, iii. 1896, p. 185.

One specimen from Zengeragusu, also seen at Lumbo.

The largest Morogoro specimen measured $58\frac{1}{4}$ inches (919+548); the Zengeragusu female is $53\frac{5}{8}$ (933+415).

The Morogoro specimen laid 8 eggs on 16. i. 18. These measured 27 × 15 mm. The yellowish parchment-like shells were irregular in outline with many concavities. They were laid singly at intervals of five to ten minutes. The Zengeragusu snake laid two eggs on 24. xii. 21 which were dry when found, they then measured 38 × 15 and 34 × 14 mm. respectively. As the snake escaped the following day it is probable she would have laid more.

This is an essentially arboreal species and offers one of the finest examples of cryptic colouring amongst East African snakes. The long and slender body is vine-like in its proportions, and coloured for the part. In Morogoro specimens the crown of the head was leaf-green and not unlike a leaf in shape; the Zengeragusu snake had the crown of its head the same colour as the body however. The tongue is bright red with a black tip. When annoyed or scared they inflate their throats vertically like a Boomslang does.

I have already mentioned the swallowing of a *Typhlops mucruso* by this Zengeragusu snake in captivity. Two months after its escape it was killed in a tree only 200 yards from its cage and then had a *Chamæleon dilepsis* in its stomach.

Dispholidus typus Smith.

Blgr. Cat. Snakes, iii. 1896, p. 187.

Two specimens of the Boomslang or Ngole, as it is known in Kiswahili, were taken at Kilosa and Lumbo respectively.

The largest male measured 56 inches (1027+393) and female 69¼ (1269+489), the latter being 258 mm. longer than the maximum given in the Catalogue. These two snakes were the finest of a series of eleven collected at Morogoro. Of the two snakes under consideration, the Kilosa one was bright green and the Lumbo snake brown.

In captivity they ate sunbird, wagtail, weavers (*Ploceus*, *Uræginthus*, *Lagonosticta*), warbler, bulbul, and swallow. The Kilosa snake when shot had the remains of a black swallow (*Psalidoprocne* sp.) in its stomach.

The Lumbo Boomslang, 68¼ inches in length, had a chameleon (*C. dilepsis*) in its stomach. At Morogoro a Brown Boomslang fell out of a tree in the avenue, together with a chameleon. A green Boomslang and a chameleon of mine escaped, and later I recaptured the snake close by with what was probably the same chameleon in its mouth. A few days later a second brown Boomslang fell out of the same trees with a chameleon. All these incidents occurred within a month of each other, showing that though the Boomslang may like a chameleon diet it has considerable difficulty in mastering its prey, seeing that no fewer than three fell out of trees while attempting to do so.

I therefore introduced a chameleon into the cage of a very large and black Boomslang. The snake immediately approached the chameleon, sliding silently towards it with raised head; the chameleon thereupon raised its occipital flaps, inflated its throat, and swayed about from side to side, suddenly lunging forwards with widely gaping mouth and uttering a hiss. I then removed the chameleon from the cage, but fed several snakes on chameleons later when pushed for other food.

CALAMELAPS POLYLEPIS Bocage.

Blgr. Cat. Snakes, iii. 1896, p. 246.

Two specimens, one dug from a termite mound at Lumbo, the other found in a bottle at Morogoro without date, but as all the other material in the bottle was local I have little doubt that it was collected in Tanganyika Territory. This species is only known from Nyasaland and Angola before.

Lumbo male measured $17\frac{7}{8}$ inches (405+47). Scales 19, 176, 30, 6. The maximum number of caudals given in the Catalogue is 27.

RHINOCALAMUS MELEAGRIS Sternf.

Sternf. Mitt. Zool. Mus. Berl. iv. 1908, p. 244.

Found on a path at Gonja (29. v. 16), measures $11\frac{5}{8}$ (269+25); originally described from Lamu Is., K. C. I believe the identification to be correct, though the number of ventral scutes cannot be determined as the snake was stepped on and slightly damaged. It has 15 scales at mid-body, 28 subcaudals, 7 labials, and was presented to the E. A. & U. Nat. Hist. Society at Nairobi, in whose museum it now is.

APARALLACTUS JACKSONII Günth.

Blgr. Cat. Snakes, iii. 1896, p. 256.

The longest of five specimens collected at Longido West measured $10\frac{7}{8}$ inches (228+48).

APARALLACTUS WERNERI Blgr.

Blgr. Cat. Snakes, iii. 1896, p. 257.

Single individual from Bagilo, Uluguru Mts., measured $10\frac{1}{2}$ inches (203+45).

APARALLACTUS CAPENSIS Smith.

Blgr. Cat. Snakes, iii. 1896, p. 259,

Seventeen specimens collected at Lumbo about the roots of grass or shrubs, or on the surface of the sandy soil in the early morning. The largest of this good series was 47 mm., less than the maximum given in the Catalogue.

Earlier in this paper I have referred to a worm snake being eaten by this species in confinement,

ELAPECHIS GUENTHERI Bocage.

Blgr. Cat. Snakes, iii. 1896, p. 359.

One female from Nairobi (21. viii. 19) measuring $23\frac{3}{4}$ inches (545+43), in whose stomach were four lizard's eggs measuring 8×4 mm. Is it possible that the snake had swallowed a pregnant lizard and that the gastric juice had not acted on the covering of the eggs?

ELAPECHIS NIGER Günth.

Blgr. Cat. Snakes, iii. 1896, p. 359.

A single specimen from an ant hill at Lumbo; another was killed but badly smashed in the same hill. I also encountered a third specimen in November 1920 just before dusk on the Uasin Gishu Plateau near the Burnt Forest. I held it down with my cycle pump till I had had a good look at it. As I had lost my way I had other things to think of than its preservation, and so released it. Lumbo female $20\frac{1}{2}$ inches (488+32) with 142 ventral scutes.

NAIA NIGRICOLLIS Reinh.

Blgr. Cat. Snakes, iii. 1896, p. 387.

Twelve specimens of the Black-necked Cobra, known as Kigau in Kikami and Fera in Kiswahili (not Pili as given in sundry dictionaries, which is the Puff Adder), were met with at Morogoro, Rudewa, Kilosa, Mtali's, Tabora, Mwanza Dist., Frere Town, Nairobi, and Lumbo.

The Lumbo specimens are referable to Peters' var. *mossambica*, Nairobi ones to *forma typica*. Mtali snake was all black with no throat markings. Mwanza Dist. example was black above, mottled black and white beneath, no red on throat. Tabora specimen had the throat red-banded, being young it was plumbeous above. I came upon it as I was clambering over a kopje, and it came straight for me for the best part of a yard with hood spread, spat at me, then turned into a crevice, which was the reason it approached, "home" being between us. It struck me that the red and black bands on the throat are obviously "warning colours."

It is curious that of a score of specimens collected all have been females hitherto; one had 180 and another had 181 ventrals, two had 51 and two 53 subcaudals.

During September 1920 an Indian juggler who had a captive cobra brought me ten eggs measuring 35 × 17 mm. recently laid by it. The eggs are usually deposited in old termite hills.

Mammals, birds, reptiles, and amphibia are alike included in the dietary of this species, and no doubt this fact explains its wide distribution and numbers. On arriving at Frere Town (17. v. 18) I was informed by my host that he had been much plagued by a cobra in his fowl-house. During the three previous nights it had killed six pigeons, two pigeons, and one pigeon respectively. At seven o'clock that evening I received a message that the cobra was now in the fowl-house coiled among the rafters about twelve feet from the ground. On arrival I saw a capture was impossible and sent back for a ·410 gun, from which I delivered a charge of No. 10 shot. The concussion in the small iron building made such a dust that we had to retire: a flop, and down fell the cobra at our feet still writhing and striking this way and that. It measured $64\frac{1}{2}$ inches, and in its stomach was a young pigeon, whilst two pigeon's eggs were in its gullet.

Twelve days later, just after dark, there was another great outcry amongst the poultry, and my host running out with a stick surprised a $66\frac{1}{2}$-inch cobra swallowing a chicken, taken thus at a disadvantage it was easily dispatched. It was of course stated that it was the mate of the first, come in search of its fellow, but unfortunately for this popular belief both were females.

At Morogoro, a native brought me a chicken coop containing one dead cobra, one fowl ditto, and three chickens, one of which was headless. A few days before, this snake was supposed to have taken three chickens from the same coop. This time the boys hearing cackling ran out and killed the snake, but not before it had bitten the fowl and her brood. Opening the snake I found one chicken in its stomach and a chicken's head in its gullet, and so surmise that it was in the act of swallowing it when struck by the boys, who probably knocked off the chicken's body in their attempts to strike the snake's head. Length 51 inches.

I have already spoken of a cobra killed whilst swallowing a sand snake. I have known one to eat four toads (*B. regularis*) in a fortnight, another three in one day, and a still more remarkable case of gluttony occurred at Morogoro. I went out with a lamp and put two toads in the snake's cage, which was occupied by a half-grown cobra only. It seized the first toad and on my return was chasing the other round the cage with the first in its mouth; it struck at it again and again, but of course without effect. It then paused and swallowed very energetically. When the first was disposed of the second was bitten in the abdomen, held for half-a-minute, then released, but as it began to hop it was seized by the hind leg, and for nearly twenty minutes the cobra attempted to swallow it hind end first. At the end of that time it took the head in its mouth and swallowed it with ease. Precisely the same thing occurred with the third toad, which speaks badly for the reputed intelligence of the cobra. A fourth and fifth toad followed, but I did not stay to witness their engorgement. Six days later this half-grown cobra had resumed its normal proportions.

Its dietary leads it to frequent the haunts of man, where it is frequently found in sheds, fowl-houses, rubbish heaps, and tents. In the bush they prefer to take up their abode in termite heaps, upon which they lie and bask in the morning sunshine.

I know of a family residing near Nairobi in which nearly every member, and many of the employees about the farm, have been spat at in the eyes at one time or another. I wish to emphasise this point that the cobra deliberately aims at the face, as only the other day I read in a journal that it was a matter of accident when the venom reached the eyes. The lady of the household referred to, on going to the fowl-house, where it was none too light, saw something dark in one of the boxes, and supposing it to be a fowl she bent over it and received a charge of venom full in the face, the resultant shock and pain was so severe that she sank down on her knees and called for help.

This cobra rarely bites, so the following case, which occurred at Kilosa on 26. v. 21, is of interest. A very intelligent native in my employ was returning home one evening at dusk (6.30 p.m.) when he stubbed his foot against what he thought was a stick lying across the road. Next moment with a short hiss the cobra launched at him and struck with both fangs just above the left ankle—his feet being bare of course. The snake withdrew immediately and set off in the direction of the railway line; he ran after it, and the snake rose and spread its hood; he looked about for a stone, but his friends called to him to withdraw or he would get bitten again. He rejoined his companions, and very soon began to feel sick, so he went to a native (Wanyimwezi) "doctor," who first applied a ligature above the knee and then made from nine to a dozen horizontal incisions above the site of each fang-mark, *i.e.* between the bite and the heart, and into these rubbed some "medicine."

Ramazan was taken home by his friends, and on arrival ate some mealie-meal (usual evening food), but threw it all up. Every time he attempted to eat the following day he was unable to keep anything down, and he said he felt successive waves of venom come up from the leg as far as his throat and then recede again. By the 28th he was well enough to return to work.

I met a weird old "snake charmer" in Mwanza Dist. who had in his possession a 68-inch cobra, which he kept in a small bark basket. The first time I saw him playing with it, the snake slid out when he came to put it back in its box; this happened two or three times, and he slapped it on the head, when, quick as thought, it apparently attempted to spit in his face (and as he was stooping over the box his face was not two feet from the snake). I was within four feet myself and remarked that no venom accompanied the open-jawed hiss, and he replied with a laugh that the venom was finished. He elected to become a camp follower for a small consideration. A few days after, when he was holding his daily display—tying the cobra round his naked waist or wrapping it two or three times round his neck and flinging its head over his shoulder, so that it struck his back with a resounding whack, —my curiosity was so piqued that I bought it from him and chloroformed it. The poison teeth and parotids were intact!

Among the parasites of this snake were worms (*Diaphanocephalus simus* Daubeney 1923 and *Polydelphis quadricornis* (Wedl.), also ticks. The tick (*Aponomma exornatum*) was taken on a Nairobi cobra.

NAIA HAIE Linn.

Blgr. Cat. Snakes, iii. 1896, p. 374.

Though this snake ranges from Arabia and the borders of the Sahara northwards to Zululand, neither Tornier nor Sternfeld give any definite localities in Tanganyika Territory for the

Egyptian Cobra, and the present specimen from Kilosa is only the second which I have come across. It was shot by Capt. Turnley beneath a rock in a dry ravine called Mbweni and is now in the Game Dept. collection.

Male just under 6 feet (1475+325). Scales 17, 108, 69, 7; the second labial on the right side is divided.

The stomach was found to contain a mass of mammal fur and a piece of tree bark measuring 31×26 mm. obviously swallowed with the food.

Dendraspis angusticeps Smith.

Blgr. Cat. Snakes, iii. 1896, p. 437.

Six specimens from Morogoro, Chanzuru, and Kilosa, and a 7-foot specimen killed in the passage of a house at Mombasa.

The largest male was 94 inches (1880+502) and largest female was 97½ inches (2332+139), Morogoro. Both Kilosa snakes were bright leaf-green and under 6 feet.

Two newly-hatched young with the umbilical cord still unhealed were found on March 5th and 31st respectively, both at the same spot.

The one Kilosa specimen which was brought to me alive fed with avidity on dead rats; in fact, I think being nervous of large rats, mambas prefer them dead. As with my Morogoro examples, it would not commence to feed if anyone was about, possibly realising that it was at a disadvantage; however, by returning quietly I succeeded in watching it feeding.

Viperidæ.

Causus rhombeatus Licht.

Blgr. Cat. Snakes, iii. 1896, p. 467.

Three examples of the Rhombic Night Adder were taken in Nairobi and the Ngong Forest.

During one week one of these adders swallowed a largish frog, three small toads, and nine very small toads. On being chloroformed a week later and its stomach examined, all were found to have been completely digested except the feet of the frog. Another snake was seen by me to take seven small toads one after the other, each about the size of a thimble.

Causus resimus Peters.

Blgr. Cat. Snakes, iii. 1896, p. 468.

Two were taken at Luguo and Sagayo.

The Luguo specimen, though on reddish soil, was a beautiful grass-green; the Sagayo specimen, on the same kind of ground, was the usual greyish olive. Both with the normal markings. The former had 7 labials on the right lip and normal 6 on left; the latter 26 pairs of subcaudals.

CAUSUS DEFILIPPII Jan.

Blgr. Cat. Snakes, iii. 1896, p. 469.

A single specimen from Bagilo, Uluguru Mtns.

The largest of 15 specimens collected at Morogoro measured $16\frac{3}{4}$ inches (293+32); this series shows that the number of ventrals may range from 110 to 129.

CAUSUS LICHTENSTEINI Jan.

Blgr. Cat. Snakes, iii. 1896, p. 470.

This specimen was one of nine collected on the Yala River by Mr. H. J. Allen Turner and is now in the Nairobi Museum. Typical specimens are olive-green in life and plumbeous or lead-colour when preserved; the specimen under consideration agrees in every way with the published description of *C. lichtensteini*, except in the unusual markings and number of ventrals; but typical specimens from the same locality have also the same number.

Head and body 200 mm.; tail 15 mm.; costals 15; ventrals 158; caudals 17; labials 6.

General colour grey (brilliant leaf-green in life like *Chlorophis*, but with a velvety tone—Turner). Head black. White line commencing at the first scale behind the last labial following the outline of the head passing along the edge of the supraoculars just above the eyes, and finishing on the corresponding scale on the other side. Lower portion of all the upper labials and whole of the 3rd china-white. An inverted V on nape, apex just reaching to posterior border of parietals. Throat pure white with a black U corresponding to outline of throat and reaching to oral margin on the second labial only. Third and fourth gular scales (or ventrals) black, 5th and 6th white, 7th, 8th, and 9th black, 10th and 11th white, remaining ventrals grey with faint white transverse bars on every 13th or 14th scale. Black V-shaped markings along whole of dorsal surface at intervals of seven to nine scales; nine very distinct white lateral marks corresponding to bars on the belly, the 10th just above vent forms a complete white ring three scales wide, white spot near tip of tail, white freckles on anterior part of black.

Another specimen Mr. Turner tells me was quite black in life, similar to its preserved colour; a brown stripe from the posterior border of the eye passes along the whole outer row of body scales; the only other marking is a transverse brown band four scales wide across the back above the vent. Its formula is as follows:—267 mm.; 26 mm.; 15 . 144 . 20 . 6.

BITIS ARIETANS (Merr.).

Blgr. Cat. Snakes, iii. 1896, p. 493.

Twenty-one Puff Adders from Nairobi, Morogoro, Kilosa, Kipera, Mpanira-kwa-Sagoi, Mpwapwa, Usshora, and Lumbo.

Most were taken lying on paths, but some in clearing or burning grass.

The largest males were $43\frac{1}{2}$ and $40\frac{3}{4}$ inches from Kilosa, the largest females $41\frac{1}{2}$ and 39 inches from Morogoro, but none of these exceeded Catalogue dimensions. It is interesting to note that the skin of the largest when dried measured 52 in.

The coloration is extremely variable in East African Puff Adders, which may be lemon-yellow, chocolate-brown, or brick-red, or intermediate between these three main types. A young reddish Puff Adder cast its skin on Nov. 7th and appeared in a cream-and-brown skin; exactly three months later, *i.e.* Feb. 9th, he sloughed again. On 17. viii. 21, I made a comparison of two young local snakes. A nut-brown one had a black spot on the lateral portions of each 5th ventral scale approximately. The reddish viper, on the other hand, had the whole of the under-surface chequered with black like a Tessellated Snake.

The smaller of the two males whose measurements are given above was most unusually coloured: the black V-shaped markings had a lighter outer edge of old gold; posteriorly there were rectangular patches of the same colour. Another snake from Kipera which was driven out by fire from a woodland of maiombo bush, and which harmonised most wonderfully with the reddish soil and fallen brown and yellow leaves, had the V-shaped markings vermilion, black, and cream, the rest of the back being brown.

Some small boys informed me that two Puff Adders, which are known to the Swahili as "Moma" or "Pilipili," were mating in the scrub not far from where I was. There was only the male to be seen when I arrived, a very fine one, and it lay with hemipenes extruded perfectly motionless, nor did it move when I quietly placed a forked stick on its neck, not till I picked it up did it commence to struggle. Pairing was taking place on Aug. 20th. A female very heavy in young was killed on 13. i. 21.

The Mpanira Adder had swallowed a largish bird whose quills were undigested. A younger specimen had an orthopteran in its stomach in addition to a young toad. Toads (*Bufo regularis*), but more often rats (*R. c. microdon*), are their principal food; so many persons have kept and recorded the feeding habits of this species that there is no object in my doing so here.

Three notes on the effects of their bite may not be amiss. A fine conditioned male Bushbuck was picked up at Kilosa on 26. iii. 21. There was a single puncture on one haunch, and from the fluid condition of the blood and general hæmorrhage I should certainly say that the buck had laid upon (?) and been bitten by a Puff Adder that morning.

When in the bathroom, my wife saw a rat entering by a hole which drains away the bath-water. When just clear of the hole, it struggled violently as if to free itself, and she thought she saw a snake's head and called to me that there was a snake there. The rat, meanwhile, ran up to the window-sill and entered a blind hole; by the time I reached the room, the rat had jumped to the wash-stand and was lying dead with blood flowing from its left hind foot. As Puff Adders are very common here and Cobras rare, I am fairly certain it was the former. This occurred about 3 p.m., and I laid the rat by the hole, when, sure enough, it disappeared at dusk, as I supposed it would.

Just before dark one evening I was passing the cases containing snakes when I saw that a 2-foot Puff Adder had forced its head through a broken corner of the glass door. It could not get out further as it was too fat, nor could it withdraw itself owing to the triangular shape of the head. Taking hold of its neck with forefinger and thumb, I eased the belly scales past the glass with the left hand, then, shifting my grip to the head, was pressing on the quadrate bones and was on the point of letting go when the snake twisted round and drove its left fang down my thumb, scoring it so that it at once began to bleed. I imagine no venom was liberated, as I suffered no serious consequences, though all precautions were immediately taken, my native helper lancing and ligaturing my thumb, which was immersed in a solution of permanganate so strong that it took all the skin off. I might add that I put a rat into this Puff Adder's cage the following morning; the snake bit it, and the rat died very promptly and was duly swallowed. Whilst we were in camp at Lumbo a native died in hospital from a Puff Adder's bite.

A very large percentage of Puff Adders are infected with nematode worms, which I believe at times are the cause of death, thus: Kilosa, 28. vii. 21—Young male adder found dead about fifteen feet from the kitchen door. Its stomach and intestines were very full of rat's fur; in the œsophagus were a large number of immature ascarids which Dr. Baylis states are probably *Polydelphis quadricornis* (Wedl.).

Kilosa, 19. vii. 21—One of my Puff Adders not having fed for four months and being obviously unwell, I killed it. Beneath the skin it had four nodules or flattish lumps of flesh-like substance about $\frac{1}{2}$ inch long, $\frac{3}{8}$ inch wide, and $\frac{1}{8}$ or $\frac{1}{4}$ inch thick; these united the skin with the spine so that the reptile could not be skinned. Another snake killed the same day had a large number of minute nematodes in the œsophagus which Dr. Baylis states are *Diaphanocephalus* sp., and adds that the species is being described from other material by Daubeney under the name of *D. obliquus*.

In another the viscera was teeming with *P. quadricornis*, and there was also a tapeworm in the stomach.

BITIS GABONICA Dum. & Bibr.

Blgr. Cat. Snakes, iii. 1896, p. 499.

My native collector shot a very fine specimen in the Usambara Mtns. and preserved the skin. I examined a second specimen from Kilwa, which is on the East Coast south of Dar es Salaam.

Atractaspis rostrata Günth.

Blgr. Cat. Snakes, iii. 1896, p. 514.

Six specimens of the Snouted Burrowing Viper were collected at Lumbo from August to October 1918, and a female at Kilosa in April 1923.

All but one were females, and the largest of these measured $24\frac{1}{2}$ inches (614+8); a male had 21, not 23, scales round mid-body.

These snakes are surprisingly quick, and when going to pick one up in a tent (it having been discovered by the moving of a box) it struck at my thumb. As I saw the snake lunge I was also quick in withdrawing and just felt a prick on the top of my thumb, which at the time happened to be protected with somewhat horny skin; no venom was visible.

44. Notes on East African Birds (chiefly nesting habits and endo-parasites) collected 1920–1923. By Arthur Loveridge, F.E.S., C.M.Z.S.

[Received August 14, 1923: Read November 6, 1923.]

The collection for which the birds mentioned in this paper were shot consists of 1558 skins representing 57 of the 63 families of East African birds, 311 of 398 genera and 761 species. Only 150 eggs were taken in the period covered by this paper.

As before*, a few notes on some of the European migrants have been included, but with this exception simple records are avoided, though many rarities such as *Cossypha albigularis* Rchw., *Callene sharpei* Shell., and *Turdinus stictigula* Rchw. were collected.

Dr. Hartert† has described the following species and races from the present material:—*Cinnyris loveridgei*, *Arizelocichla neumanni*, *Eremomela flaviventris tardinata*, *Turdus milanjensis uluguru*, *Lioptilus stierlingi uluguru*, and *Saxicola torquata promiscua*; and Dr. Neumann‡, *Anthreptes longuemarei neglectus*.

My grateful thanks are due to Dr. Hartert and Mr. Arthur Goodson for going through a great deal of the collection and making the necessary determinations. To Dr. Baylis also for much kindness shown in the identification of the parasitic worms mentioned in the following pages.

The only localities outside Tanganyika Territory referred to are Frere Town and Nairobi. As difficulty may be found in locating some of the other places (English and not German spelling of place-names is given), I have arranged them according to their districts and as far as possible from east to west and south to north, *i. e.* working from the Central Railway.

Dar es Salaam District.—Dar es Salaam, Pugu.

Morogoro District.—Bagilo, Morogoro, Mkindo River, Wami River, Mkata River, Tindiga, Kimamba, Ilonga, Kipera, Madazini, Kilosa.

Dodoma District.—Dodoma, Kilamatinde, Mahaka, Mbonoa, Ndogwe, Suna, Mbulu's, Mdjengo's.

Kondoa-Irangi District.—Mtali's, Zengeragusu, Usshora, Ulugu.

Tabora District.—Tabora, Izikisia, Ndala, Simbo, Tambali, Luguo, Wembere Flats.

Mwanza District.—Mwadira, Shanwa, Sagayo.

I witnessed an interesting display of curiosity exhibited by birds at the sight of tortoises. A cage containing tortoises was

* Loveridge, P. Z. S. 1922, pp. 837–862: "Notes on East African Birds collected 1915–19."

† Hartert, Bull. Brit. Ornith. Club, xlii. p. 49; xliii. p. 149; xliv. p. 6, 1923.

‡ Neumann, Sonderabdruck aus Ornithologische Mon. xxx. p. 1 (1922).

placed on the path one afternoon at Nairobi, and the tortoises were trying to get out. Some forty birds collected, and evinced the greatest interest, craning their necks this way and that and uttering cries. Twice a sunbird hovered close to the cage the better to observe. I noted ten species of birds through the glasses, and they remained for half-an-hour, and only left because disturbed; therefore I had ample opportunity of watching them. The species represented were:—

Nectarinia kilimensis Shell.
Parus albiventris Shell.
Serinus icterus Vieill.
Serinus striolatus affinis Reichn.
Passer griseus suahelicus Neum.
Ploceus reichenowi Fisch.
Ploceus spekei Heugl.
Cossypha heuglini Hartl.
Dioptrornis fischeri Rchw.
Colius striatus kikuyuensis van Som.

NECTARINIDÆ.

CINNYRIS SENEGALENSIS INÆSTIMATA Hartert.

A nest containing two fresh eggs of the East African Purple-shouldered Red-breasted Black Sunbird was blown down from a mango-tree in which it had been built (Kilosa, 18. vii. 21).

A nest which was being built last month in a rhododendron-bush, within six feet of the verandah and seven feet from the ground, held two perfectly fresh eggs of a very pale colour to-day. Unfortunately in replacing it I cracked one. The bird, however, continues to sit on the remaining egg. She leaves it a great deal during the day, and on returning flies straight into the nest from another bush thirty feet away; hitherto I have never seen her perched on the home bush (Kilosa, 27. xii. 21).

Latterly I have seen the bird cling to the front of the nest before entering. Within the past few days the egg has been blown out of the nest! (Kilosa, 1. i. 22).

A month after the egg was blown down, the nest itself suffered the same fate. The bird is now sitting on her new nest fastened to the tip of a branch of a rubber-tree and about twelve feet from the ground (Kilosa, 12. ii. 22). A nest containing young is suspended from the tip of a branch of a big tree (Kilosa, 15. i. 23). A nest with two fresh eggs (Ilonga, 19. iv. 23).

CINNYRIS LOVERIDGEI Hartert.

During the month of May 1922 my native collector obtained two adult males and two immature females of this species, hitherto only known from a single male collected on 24. vi. 21. These four specimens come from Bagilo, Uluguru Mtns., Tanganyika

Territory. Some adult females were afterwards obtained; they are very similar to the male. As the immature plumage has not been described, I do so here.

Upperside olive-green, with slight bluish-grey iridescences becoming so pronounced on head as to form a smoky-blue crown; tail-coverts yellowish-olive; wings blackish-brown; outer webs of the primaries with very narrow, inner with wider olive-yellow outer edges; lesser and median upper wing-coverts like back, longest like primaries; sides of head like crown; throat greyish anteriorly, greenish-yellow posteriorly and on forebreast; breast, abdomen, and under tail-coverts whitish-grey with yellow wash.

Wing 54 mm. in this specimen, which is being presented to the Tring Museum; 56 mm. in second specimen in my own collection; tail 38 mm.; outer tail-feathers 28 mm.; bill from forehead 21 mm.; tarsus 20 mm.

Paridæ.

Anthoscopus caroli subsp.

A nest of the Penduline Tit containing almost fully-fledged young was found in a tree about 20–25 feet from the ground. Tree of the maiombo type in scattered bush-country on a hillside (Kilosa, 27. xii. 20).

Motacillidæ.

Motacilla aguimp Dumont.

A nest of the African Pied Wagtail (in the thatch of a hut) which held one egg on the 12th had three to-day (Simbo, 12. xi. 21).

A nest with three young several days old was found in a thatch, the young being fed on termites which were flighting strongly after recent rain (Ndala, 15. xi. 21).

A bird was seen to leave nest in thatch containing one egg which had a fairly advanced embryo in it (Tabora, 18. xi. 21).

Young ones were found in a nest in a thatch only eight feet from the ground a few days ago and flew to-day (Kilosa, 29. vii. 22).

Yesterday being the first rainfall of the lesser rains, I examined the nest referred to in the last note, and was surprised to find the bird brooding three eggs in the old nest. The species is obviously double-brooded. I was particularly pleased, as the young were taken by a native from the last sitting, and I returned them amidst much clamour from the old birds, which show confidence by re-using the same nest (Kilosa, 18. xii. 22). Young standing up in nest (31. xii. 22). Nest empty (4. i. 23). Fresh nest built alongside but four inches from the old one. Bird pulling grass from thatch to build with (15. ii. 23). Three eggs in nest (early iii. 23).

FRINGILLIDÆ.

EMBERIZA FLAVIVENTRIS Steph.

A nest of the Yellow-breasted Bunting was found yesterday; it contained two eggs, and is situated in a maiombo-bush five feet from the ground. The third egg completing the clutch was laid to-day. The eggs are very similar to those of the English Bullfinch. The nest is built of dry grass-stalks lined with very fine roots or root-fibres; it is rather untidy and exposed. The bird is extraordinarily wary, and will not approach the nest when anyone is in the vicinity (Kilosa, 24. xii. 20).

SERINUS SULPHURATUS SHELLEYI Neum.

Three eggs were found at Kabare on 11. i. 23. The nest was made of fine rootlets and lined with down from plants. Bird shot.

PLOCEIDÆ.

URÆGINTHUS NIASSENSIS Rchw.

Two nests of the Nyassa Blue Waxbill, each with two eggs (Kilosa, 5. ii. 21). Nest and two eggs (11. iv. 21). Nest and five fresh eggs (30. v. 21). Two nests near house contain young (19. iii. 21). Two more nests found; one the bird has not finished building and is still carrying grass; the other bird is sitting on a clutch of eggs (25. iii. 22). The bird which was building on the 25th has now four eggs. The nest, which is built in a lime-tree six feet from the ground, merely rests on the branches, and can be lifted off and replaced without disarranging it; it is neatly lined with fowl feathers (5. iv. 22).

Casually looking out of the railway-carriage window at the telegraph posts (which are girders set upright with a smooth surface on the west and a concavity on the east), I was struck by the number of posts carrying nests (presumably last year's), and from the time I started counting till we reached the station, I had counted 47, which did not include the remains of old nests. It interested me, as it showed the adaptability of the species to modern conditions, for they had seized on this site in such numbers that two out of three posts were occupied despite the abundant bush close by. Another species of Weaver (*Ploceus* sp.) had gone one better in selecting a snake-free site, and a number of its nests were attached to the wires midway between the posts, though some were against them, but not more than half-a-dozen nests of this kind were seen (Pugu, 17. vi. 22).

LAGONOSTICTA SENEGALLA ?

A nest built over that of some wasps was in a small tree and contained young (Kilosa, 13. xi. 22).

Pytelia afra cinereigula Cab.

A nest containing four fresh white eggs measuring 16 × 12 mm. was found in a maiombo-bush about seven feet from the ground; the bird had just commenced sitting (Kilosa, 25. iii. 21).

Dinemellia böhmi Rchw.

Giant Weavers were usually met with in parties numbering three to six individuals, of which one would be in a tree (? on guard) and the others feeding on the ground. They were extraordinarily difficult of approach. They were seen building their huge nests of twigs at Usshora (27. xi. 21), Ulugu (7. xi. 21), Wembere (8. xi. 21), Luguo (9. xi. 21), Tambali (10. xi. 21), Simbo (12. xi. 21). I have not seen them elsewhere.

Anaplectes rubriceps Sund.

A Red-headed Weaver flew from nest containing one fresh egg measuring 20 × 14 mm. and of a uniform pale blue colour. The nest was situated at the extremity of an acacia-thorn branch overhanging the road, about ten feet from the ground. Some rain had already fallen in the district (Tambali, 11. xi. 21).

A nest was found containing two very unequal-sized young in it (Izikisia, 16. xi. 21).

Quelea sanguinirostris intermedia Rchw.

From 4.30 to 6.30 p.m. a most extraordinary flight of Southern Masked Weaver-Finches took place; millions of birds must have taken part, and I have never seen anything like it. They were in a series of huge flocks which had almost the appearance of smoke as each thinned and thickened in the undulating flight. The intervals between the flights were very small, so that there was practically one continuous stream of birds following the course of the river N.E. to S.W. to their sleeping places in the reed-beds (?) of a large body of permanent water called "nyanza" by the local natives (Simbiti River, 13. x. 22). About 7 a.m. we were fortunate in witnessing part of the return flight, but it was a mere nothing compared with the evening flocks (14. x. 22).

Corvidæ.

Corvultur albicollis Lath.

A pair of White-necked Ravens made a great outcry on my approaching a rocky kopje where a nest was found under an overhanging rock at a great height. The young appeared to have flown, but there was no sign of them (Mbulu's, 11. x. 21).

A nest was found in an almost inaccessible situation under an overhanging rock on some rocky hills. It contained four very markedly different eggs and a newly-hatched young one (Mtali's, 22. x. 21).

I visited the last-mentioned site a little earlier this year and found five eggs; the bird had only just commenced to sit. My collector obtained the eggs by fastening his fez to a withy and fishing them out one at a time, which he accomplished successfully though in a very precarious position himself all the time (Mtali's, 9. x. 22).

Corvus scapulatus Daud.

The nest of a White-bellied Raven was found in a bussu-palm about forty feet from the ground, the palm being in open bush-country. The nest, which was on a heavy base of twigs, had a lesser foundation of bark cord commonly used, and discarded, by porters. On this was a thick lining of goat's hair and a few ends of string. It contained four typical crow eggs measuring 41×28 mm., much smaller than the raven's, which were 50×33 mm. (Izikisia, 16. xi. 21).

Nest at the top of a slender fir-like tree in the town contained three young. Nest was fully sixty feet from the ground (Kilosa, 28. xi. 21).

Building in a baobab at Pooma (4. x. 22). Four newly-finished nests in stunted trees growing from the rocks at Shanwa (21. x. 22).

Dicruridæ.

Dicrurus afer lugubris Hempr.

When collecting lepidoptera I caught a Black Drongo in my net; its stomach contained beetles (Frere Town, 29. vii. 20).

Flushed a bird from its nest built in the fork of a branch of a low tree at a height of seven feet from the ground. The nest was made of fibres and grasses fastened together with spider-web but unlined. It held three perfectly fresh eggs, one of which was misshaped with a protuberance at the lower pole. The ground-colour of these eggs was slightly pinkish, upon which were superimposed brownish-red blotches, particularly thick around larger pole. I watched a male displaying a few days ago, rising and diving before the female which was sitting on a tree (Tambali, 21. x. 21).

Laniidæ.

Lanius cabanisi Hartert.

Nest built entirely of rootlets (coarser used for exterior, finer for lining) measured $5 \times 4\frac{1}{2}$ inches outside, $4 \times 3\frac{1}{2}$ inside, and $1\frac{1}{2}$ inches in depth. Clutch consisted of three fresh eggs measuring 26×19 mm. Pale olive ground-colour, with blotches of purplish-brown and brown grouped around the larger pole; a few scattered elsewhere (Tindiga, 26. i. 22).

Lanius collurio Linn.

A Hippoboscid (*Olfersia* sp.) was taken on a shrike at Kimamba, 3. iv. 23. Worms (*Filaria nodulosa* Rud.) from a Dar es Salaam specimen, 24. i. 19.

Harpolestes senegalus orientalis Cab.

The Coastal Large Bush-Shrike was nesting at Kilosa on 5. i. 23. Full clutch of two eggs in a maiombo-tree at a height of seven feet from the ground.

Malaconotus poliocephalus blanchoti Steph.

A nest of the Brown-breasted Giant Shrike with three eggs was found by my collector (Kilosa, 16. xii. 21).

Campophagidæ.

Coracina pectoralis Jard. & Selby.

A female White-bellied Grey Cuckoo-Shrike, which is the first I have obtained in this district, had a nematode (*Physaloptera* sp.) in its stomach (Kipera, 8. ix. 22). Mr. Goodson notes that the wing and general size is smaller and somewhat paler than in typical West African *C. pectoralis*.

Pycnonotidæ.

Pycnonotus tricolor micrus Oberh.

A nest of the Kilimanjaro Yellow-vented Bulbul with two eggs in lime-tree seven feet from the ground; bird sitting (Kilosa, 31. xii. 22). Nest with three eggs in a thorn-bush six feet from the ground (Kilosa, 7. i. 23).

I encountered some natives chewing the red berries of some wild fruit which was very gummy and had a nasty dry taste and which they called Onembo in Kinyaturu. I thought they were eating this fruit and attempted to do so myself, but presently learned that they were on their way to trap birds, and this constituted their "bird-lime," for, when chewed, it becomes a very thick gum. This they smear on a fine thread stretched near the edge of the water-holes, which in this arid district are few and far between, and consequently much resorted to by birds, which collect to bathe and drink.

In about two hours these men returned with some twenty bulbuls and a weaver, all of which they had plucked, except for the heads which they had inserted through a string worn below the knee, the naked bodies depending. The result was quite ornamental, but they were destined to be eaten shortly. These men said that the Dongerero (local name for this bulbul) got stuck when shaking the water from their wings after bathing (Ndogwe, 1. x. 22).

I was sitting beneath a tree when suddenly, with loud cries, a very frightened bulbul fell at my feet and commenced to hop and scramble away across a patch of open ground to some rank grass fifty feet away. I had to run to overtake it, and, when caught, it was found to have its left foot and wing firmly in the grasp of a very fine leaf-insect (*Zabalius ophthalmicus* Walk.) some three inches in length. The strong grip of the insect was astonishing, and considerable difficulty was experienced in disengaging it from the bulbul, which I then released (Madizini, 3. iii. 23).

Pycnonotus dodsoni subsp.

A nest of the Mombasa Yellow-vented Bulbul containing two partly-incubated eggs was found on the mainland, Mombasa, on 27. xii. 20.

Phyllastrephus cabanisi succosus Rchw.

A nest containing two eggs was taken at Kabare on 12. i. 23. It was composed of a foundation of dry sedges and leaves and lined with very coarse rootlets.

Sylviidæ.

Eremomela flaviventris tardinata Hartert.

A nest measuring 60 × 40 mm. deep inside was composed of fine fibres, grass, and raw cotton, lined with very fine grass and a little cotton. It contained two white eggs finely speckled with black and purple spots, especially thick around the larger poles. They measured 15 × 10·5 mm. My collector shot both parent birds (the types) from the nest (Sagayo, 2. xi. 22).

Cisticola nana Fischer.

The hen bird was shot from a nest of not very definite shape loosely woven of dry grass, lined with finer grass and much down of the Javan silk-cotton tree, or kapock as it is locally called. The three eggs measured 14 × 11 mm., and were white finely streaked and speckled all over with pale pink. There were very small embryos in the eggs (Kilosa, 17. i. 22).

Acrocephalus griseldis Hartl.?

I have queried this identification only as regards the nesting note, as the nesting bird was not shot, but appeared to me to be the Lesser Great Reed-Warbler (*A. griseldis*), which I had already collected at the spot on 12. ii. 21, but the Great Reed-Warbler (*A. arundinaceus*) and the Sedge-Warbler (*A. schœnobænus*) were collected in the same swamp on 3. i. and 22. iv. 21 respectively.

Two purple-blotched eggs in a nest suspended from four sedges in a swamp. Bird sitting very close (31. v. 21). One egg hatched (Kilosa, 1. vi. 21).

HIRUNDINIDÆ.

RIPARIA FULIGULA RUFIGULA Fisch. & Rchw.

A nest of the Brown-throated Rock-Martin built under the eaves of a house contained two very bad eggs on which the bird was sitting on 17. ii. 22. On 17. iii. 22 the nest was again examined and a clutch of two fresh eggs found and taken. On 4 & 5 iv. 22 the birds had but one egg in the nest; this was left. On 1. v. 22 the bird was again sitting on three eggs measuring 19 × 8 mm. White with brownish or reddish speckles over the whole surface, with a marked tendency to grouping round the larger pole (Kilosa, 1. v. 22). In iv. 23 the nest was examined several times and the bird found to be sitting on a single infertile egg.

HIRUNDO SMITHII SMITHII Leach.

A Wire-tailed Swallow's nest containing young under eaves of my house (1. xii. 20). After a night and morning of heavy rain I found a newly-fledged Wire-tailed Swallow flapping wearily on the ground. After a few hours' drying in the house it was able to fly away (13. iii. 21). I notice a pair of these swallows have neatly trimmed off the broken edge of a nest of *H. puella abyssinica* which contained young in January and have laid two eggs (27. iv. 22); this was the full clutch (28. iv. 22). Bird just begun to sit on clutch of three eggs (31. iv. 23). Three nests each with three young (Kilosa, 6. v. 23).

Of nests examined to-day one was ready for eggs, a second held three fresh eggs, a third three hard-sat eggs, two nests held newly-hatched young, and one three fledglings almost ready to fly (Frere Town, 30. v. 23).

HIRUNDO PUELLA ABYSSINICA Guér.

Northern Stripe-breasted Swallows nesting in bath-room; young fledged to-day (13. iii. 21). Commenced building on verandah (26. xi. 21). Feathering nest; each of the three adjacent houses has also a nest (26. xii. 21). I saw one swallow on entering nest break off the entrance tunnel, which had but a poor base of attachment in the enamelled ceiling-boards (5. i. 22). As I was passing beneath the nest three-quarters of an eggshell was ejected. I therefore investigated two other nests, and found one to contain incubated white eggs without markings, the other young (6. i. 22).

The first heavy rain falling since the catastrophe of the 6th inst. set the swallows to work at repairing the damage. It is interesting to see the patchiness of the building materials, both grey and red mud in alternating patches according to the source from whence fetched (10. i. 22). Another eggshell was found beneath the nest mentioned on the 6th. These swallows are having trouble with a third, which sometimes succeeds in entering their nest (17. i. 22).

A nestling found dead beneath this nest (18. i. 22). The two remaining young ones found dead beneath nest this afternoon. They appear to have been dead some time; one had congealed blood upon its back. I surmise that they were killed by the swallow which entered the nest some days ago and caused such a commotion, and they have been thrown out of the nest by their parents (19. i. 22).

About this time there was a fresh egg lying broken beneath nest (1. ii. 22). The tunnel and anterior third of the nest have been broken down, so I have removed the rest (3. xi. 22). I revisited this house after an absence of some six months and found that these persevering birds had rebuilt the nest, which had also fallen down again and again to judge by the débris beneath. Their efforts had at last been crowned with success, as I picked up a fledgling twenty feet away. It rested quietly on my hand until its parents came sweeping around with encouraging cries, whereupon it flew for fifty yards with them flying around it all the time (31. xii. 22).

There is another nest of this species in which, the tunnel having been broken off, a pair of Swifts (*C. affinis*) built their feather and straw nest on to that of the swallows. My attention was drawn to this nest by a pair of sparrows hanging to the outside and screaming! Beneath the nest was a freshly-broken sparrow's egg, and inside the nest was a hen swift with enlarged ovules, ready to lay perhaps in a week's time (5. v. 22). A month or so later a swift's egg was found broken beneath this nest. Continual disputes between the sparrows and the swifts take place.

A Northern Stripe-breasted Swallow was found sitting on two eggs (31. xii. 22). Another nest, which has been a long time in building, hatched out young to-day (7. i. 23). These young when disturbed at night by a light make a noise not unlike that of a Square-marked Toad, and most unbirdlike. Another nest; hatched eggshell found beneath (5. iii. 23).

CYPSELIDÆ.

APUS AFFINIS Gray.

As many scores of Square-tailed White-rumped Swifts were flying about the boma and in and out of their nests, I examined dozen of the latter. They were all empty and, I believe, unlined (Kilosa, 4. vii. 22). A broken egg lying beneath a nest may have been there for a couple of months whilst I have been away. Some natives drew my attention to a swift caught in the web of a spider (*Nephila* sp.) some three feet below the guttering and two feet from the wall and fully thirty feet from the ground. The bird was perfectly helpless, spinning round and round in space. On getting it down, its feet were found to be firmly bound to the body by the viscid web, and it was so wrapped in webbing that I thought it best to chloroform it. Male. Testes small (Kilosa, 16. xii. 22).

Of thirteen occupied nests examined to-day, two had one fresh egg apiece, another held two fresh eggs, whilst a fourth had two hard-sat and a fifth three hard-sat eggs. The remaining eight held young in all stages. The parent birds all allowed themselves to be lifted off their nests. Fully nine of the nests had the nest of a Wire-tailed Swallow for a foundation. Many other nests were empty (Frere Town, 30. v. 23).

Caprimulgidæ.

Caprimulgus europæus meridionalis Hartert.

A male Mediterranean Nightjar was shot at Kilosa on 4. ii. 21, and a female at Suna, Singida, on 27. ii. 22.

Caprimulgus fossei mossambicus Peters.

Two eggs of the Mozambique Nightjar were brought to me by my collector at Kilosa, 26. xi. 20. They measured 28×20 mm. The one was addled, whilst the other held a very small embryo.

Coraciidæ.

Coracias garrulus garrulus Linn.

A female of the European Roller was shot at Kilosa on 1. ii. 21. They were observed to be very common in the Tabora District during November of the same year. Fairly common and feeding on grasshoppers at Ilonga, iii. 23. Parasitic nematodes in stomach were in too poor condition for definite determination, but were possibly *Hadjelia* sp.

Meropidæ.

Melittophagus pusillus meridionalis Sharpe.

Two newly-hatched young of the Little Southern Bee-eater were in a hole in the side of an ant-bear burrow which was occupied at the time by a pair of porcupines (Sagayo, 4. xi. 22).

Merops apiaster apiaster Linn.

Shot several European Bee-eaters, which have been numerous here for the past week or two. Their long tail-feathers are just beginning to show (27. xii. 20). These birds are still here; on several occasions during the past fortnight I have thought that they were assembling for departure. They are in excellent plumage (5. ii. 21). The bee-eaters are still abundant here (Kilosa, 13 & 30. iii. 21).

Many seen flying (Luguo, 10. xi. 21). On my return I heard the bee-eaters almost daily last week (Kilosa, 26. xii. 21). The bee-eaters are very busy with the millions of bees at the rubber blossoms (Kilosa, 6. i. 22). I heard the bee-eaters about a fortnight ago for the first time this year (Kilosa, 1. ii. 23); still here (Kilosa, 1. iii. 23). I may add that *M. nubicus*, *persicus*, and *superciliosus* are all found here quite commonly.

BUCEROTIDÆ.

LOPHOCEROS JACKSONI O.-Grant.

The Wazigoor call Jackson's Hornbill "Kwenabe," which may be specific, as they call *Bycanistes* "Hondohondo" and *Bucorvus* "Mkinga." They eat this *Lophoceros.* Two males were shot at 12 p.m. and 6 p.m., and their stomachs contained large numbers of black ants, other insects, and seeds of fruit. A female contained a stick insect, beetle elytra, seed of the "mziga tree," and fruit of the "mkongo." A third male had in its stomach a stink-ant (*Paltothyreus tarsatus*?), a black carabid, and both seeds and fruit like the female (Wami River camps, 27. viii.–2. ix. 21).

ALCEDINIDÆ.

? HALCYON LEUCOCEPHALUS CENTRALIS Neum.

A kingfisher left its burrow in a bank at the bottom of a ravine. The nest-hole was just ten feet from the bottom of the water-course, which is now dry. In the nest-hole were two roundish white eggs approximately 25 mm. diameter and on the point of hatching. Two examples of this species were found drowned in a water-butt! (Kilosa, 18. xii. 20).

CUCULIDÆ.

CENTROPUS SUPERCILIOSUS INTERMEDIUS van Som.

Caterpillars, grasshoppers and beetles, and two species of parasitic worms were found in the stomach of a female Hackle-necked Coucal (Nairobi, ix. 19).

CENTROPUS SUPERCILIOSUS LOANDÆ C. Grant.

Worms in a female were identified as *Davainea* sp. (Kilosa, 17. viii. 20). Another coucal was heavily infected with lice. One of these birds was also found drowned in the same butt as the kingfishers mentioned in a preceding paragraph.

CUCULUS CANORUS GULARIS Steph.

At 6 p.m. a Yellow-billed Grey Cuckoo was calling in the thorn-bush near camp. Its note seemed to lack the rich ringing sound it has in the spring-time at home, but was unmistakable. I answered it about twenty times, while my collector stalked and shot it—a male in bright clean plumage with large testes (7×5 mm.). The stomach contents were too triturated to be recognizable excepting for long caterpillar hairs (Zengeragusu, 1. xi. 21). Many cuckoos flying (Luguo, 10. xi. 21). Two seen at close quarters (Kipera, 22. ii. 23).

CAPITONIDÆ.

LYBIUS ALBICAUDA ALBICAUDA Shell.

Two Black-billed White Barbet nestlings were found in a hole in the banks of the (dry) Shimiyu River at Sagayo on 8. xi. 22.

PICIDÆ.

CAMPOTHERA spp.

My attention was attracted by the noise made by two young woodpeckers in a knot-hole of a thorn-tree in open thorn-bush country. The young were practically fledged and making a hissing sound; the nest-hole was only two feet from the ground (Mtali's, 21. x. 21).

Birds of another species, called "Kinente" in Kinyaturu, were seen feeding their young in a nest-hole which they had made in a branch some thirty feet from the ground. Both species had red-headed males and this species a black-headed female (Mbonoa, 29. ix. 22).

COLUMBIDÆ.

TRERON DELALANDEI GRANTI van Som.

A new worm (*Ascaridia fasciata* Baylis) was found in the co-type specimen of the Coastal Green-tailed Green Pigeon shot at Dar-es-Salaam, 7. xi. 18.

STREPTOPELIA SEMITORQUATA SEMITORQUATA Rüpp.

A nest containing two eggs remarkably different in size. One measured 36×23 mm., the other 32×24 mm. Both slightly incubated (Kilosa, 22. vi. 21).

PSITTACIDÆ.

AGAPORNIS PERSONATUS Rchw.

Four white eggs of the Yellow-breasted Love-Bird measuring 22×17 mm. were taken from a hole in a baobab-tree at Mahaka, Dodoma, on 17. iv. 22.

STRIGIDÆ.

TYTO ALBA AFFINIS Blyth.

A "nest" of the African Barn-Owl was found beneath the galvanized sheets forming the roof of a house; the bird gained admission through a small ventilating hole. Two fresh eggs measuring 40×31 mm. were found on a huge accumulation of pellets which were mostly disintegrated. Besides the very common local rats (*R. rattus alexandrinus* and *R. coucha microdon*) there were the remains of a shrew (*Crocidura flavescens*). Some of the skulls were in very fine condition, beautifully cleaned (20. v. 21). The hen bird was transferred to an aviary, where she laid an egg the following day, but instead of laying it in a big box of pellets provided, she dropped it on the floor presumably, for it was smashed (Kilosa, 21. v. 21).

A young owl, unable to fly, was picked up in the grass close to this house the following year, on 31. vii. 22. Of fifteen parasites from the stomach of this species Dr. Baylis writes that these worms are *Habronema* sp., "probably '*Spiroptera*' *penihamata* Molin, although this is said to belong to a different genus from *Habronema*."

Bubonidæ.

Otus leucotis ? granti Kollibay.

Three White-faced Scops Owls, apparently birds of the year, ♂ ♂ ♀, were flushed from a thorn-tree in fairly close thorn-scrub. Each had the remains of a single dark-coloured rat in its stomach (Mtali's, 19. x. 21).

Glaucidium perlatum Vieill.

A Pearly Owl had a large *R. c. microdon* in its stomach (Kilosa, 26. vii. 21).

Glaucidium capense scheffleri Neum.

A female with very enlarged ovules sitting in a thorn-tree in bright sunshine. Its stomach contained a male gecko (*Lygodactylus picturatus*) and a grasshopper. This is the bird that makes a peculiar bubbling note just before dusk (Wami River, 3. ix. 21).

Bubo lacteus Temm.

I was shown an empty ten-gallon petrol drum in which a Milky Eagle-Owl had nested in the fork of a rubber-tree only eight feet from the ground and fifty yards from the house. The one end of the drum had been filled in with plaited grass to induce bees to hive in it. On October 1st the Rev. R. Banks flushed an owl from it, and found the nest contained two large white eggs. To-day there was a broken shell on the ground showing faint traces of incubation; the other was missing—probably taken by a native (Kilamatinde, 5. x. 21).

Bubo africanus africanus Temm.

A Lesser Grey Eagle-Owl banged against the mosquito gauze which encloses the verandah. Was it trying to take some insect which was coming to the light, and itself misjudged the distance? I shot it, and on examining the stomach found it to contain half-a-dozen beetle elytra and one cricket (Kilosa, 18. i. 21).

Falconidæ.

Falco ruficollis Swains.

A male Red-necked Falcon shot at 8 a.m. was found to have the remains of a mouse and the leg of a grasshopper in its stomach (Izikisia, 16. xi. 21).

Falco subbuteo subbuteo Linn.

Hobby Hawks are very common here just now, their coming synchronizing with the arrival of the rains. A female shot to-day had its stomach very full of termites (Simbo, 14. xi. 21).

Cerchneis tinnunculus tinnunculus Linn.

The European Kestrel is very numerous here. In the stomach of one were parasitic nematodes which Dr. Baylis says are referable to *Acuaria* (*Dispharynx*) sp., possibly *A.* (*D.*) *recto-vaginata* (Molin) (Morogoro, 24. i. 18).

Cerchneis naumanni Fleisch.

A pair of Lesser Kestrels were killed with one shot. The stomach of the female was distended with black ants, whilst there were very few in that of the male. 8 a.m. (Izikisia, 16. xi. 21).

Elanus cæruleus Desf.

My collector found a pair of Black-shouldered Kites building at Tindiga in June 1920, but on his revisiting the place in July found that the tree had been cut down by local natives with a view to destroying the nest; two eggs were lying smashed upon the ground. Lice (*Philopterus* sp.) were found on a specimen shot at Nairobi.

Milvus migrans parasitus Daud.

Returning to camp long after dark, probably between 7 and 7.30 p.m., my attention was attracted by a huge flight of birds which passed low over our heads with much noise and whistling cries, and commenced settling in a baobab-tree some two hundred yards behind me. They were coming from an easterly or south-easterly direction, and there must have been quite three hundred of them. Having no idea what they were, I sighted two against the sky and killed four with one shot. The stomachs contained (i.) a scarab and a great many small grasshoppers, (ii.) a single grasshopper, (iii.) two grasshoppers, (iv.) empty. I visited this tree again to see if it might be the nightly rendezvous of all the local kites for roosting purposes, but there were none to be seen (Sagayo, 27. x. 22).

A great many kites are about the camp, and to-day one was picked up in an exhausted state with the skinned body of a mouse (thrown out by the skinners) fixed to both upper and lower mandibles. An examination of its claws showed that there was but one (the third in each case) on each foot. The other toes were stumps showing the metatarsal bones worn through, as if the bird had frequently tried to seize things with them. The loss of the claws was not of recent date. I kept the bird for twelve hours, but it seemed unable to feed, and in so low a state that I killed it and had the skin preserved (Sagayo, 31. x. 22).

I was informed that one of these kites was building in a palm-tree at Dar es Salaam in November (Dar es Salaam, 3. xii. 22).

An Unstriped Grass-Rat (*A. a. neumanni*) was found in the stomach of a male, shot to-day (Mtali's, 20. x. 21).

Two species of worms were found in the stomach of one kite, viz. (i.) *Idiogenes longicirrhosus* (Fuhrm.) and (ii.) *Choanotœnia infundibulum* var. *polyorchis* Klaptocz (?) (Morogoro, 23. i. 18).

HIERAÆTUS WAHLBERGI Sund.

A single example of Wahlberg's Brown Eagle was collected by the boy, who stated that he shot it when feeding on insects on the ground. It was a male and its stomach found to be distended with thousands of large yellow ants (*Camponotus* sp., I think) (Kilosa, 4. ii. 21).

In a great nest on the top of a high tree on the banks of the (dry) Shimiyu River was found a downy nestling (31. x. 22). This was removed on the 9th of November, and grew very slowly though it fed well. On 25. xii. 22 I found that one of its legs was broken, and not knit properly, owing to some carelessness on the part of the native in whose charge it was during my absence. A curious thing was that I never saw the parent bird near the nest, even though I slept in a neighbouring tree one night and visited it at the first streak of dawn. Another day I posted my collector to watch, and he said that he saw the old bird circling in the sky above, but it did not approach (Sagayo and Kilosa).

SPIZAËTUS BELLICOSUS Daud.

An immature male of the Martial Eagle, measuring two feet nine inches from beak to tip of claws, and with a wing expanse of six feet six inches, killed a vulture (*N. monarchus*) after a fight lasting half an hour which was witnessed by Capt. Turnley, who subsequently shot the eagle. On examining its stomach I found it to contain the foot of a dove or pigeon and its stomach. On opening this second stomach I found seeds and a number of small white beads (Kilosa, 5. viii. 21).

EUTOLMAËTUS SPILOGASTER Bp.

Just as I shot a Hartebeest this bird came sailing overhead and alighted in a tree close by. Its stomach contained indeterminable rodent remains and a single nematode (*Porrocæcum depressum* (Zed.)) (Kipera, 8. ix. 22).

Buteo augur Rüpp.

A male Augur Buzzard shot on a rock had a large black rat (*A. tenebrosus* ?) in its stomach (Mtali's, 19. x. 21). Another male shot in a tree had an Unstriped Grass-Rat (*A. a. neumanni*) in its stomach and in its crop a lizard (*Eremias spekii*) (Ndala, 15. xi. 21).

Two newly-fledged young were shown me by a native child who was about to eat them. I saw a nest in a thorn-tree among the rocks, but it was empty. The natives say that the buzzards nest here every year (Mtali's, 19. x. 21). A nest was seen in a tree leaning out over the edge of a rocky krantz. My collector shot the hen bird and took the eggs, which were quite fresh and measured 52 × 62 mm. They were white with brown smudges and reticulations, mostly at the lower pole, but also extending towards the upper pole (Shanwa, 23. x. 22).

Melierax canorus metabates Heugl.

An immature male Northern Chanting Hawk with two lizards (*E. spekii*) in stomach (Ulugu, 7. xi. 21). An adult male with a pregnant lizard (*Agama atricollis* ?), grasshoppers, and many parasitic nematodes, which were not preserved, in its stomach (Ndala, 15. xi. 21).

Melierax poliopterus Cab.

A nest containing a single nearly-fledged young of the White-rumped Chanting Hawk was built in a tree growing from a fissure in the rocks. Its plumage was strikingly different from the adult. The back plumage is nearly black; it has a central gular streak, but the lower breast shows signs of barring like the adult. When first seen it was being fed on an agama lizard by its parent, but it soon took to feeding itself on scraps of meat cut up small (Shanwa, 24. x. 22). The stomach of another specimen shot at Mwadira contained an agama and grasshoppers (19. x. 22).

Circaëtus fasciolatus Gray.

The Banded Harrier-Eagle is, I believe, a somewhat scarce bird; in the stomach of a male shot to-day there were remains of a rat (*R. c. microdon*) and the scales of a lizard, apparently those of *Mabuia striata* (Mkindo River, 8. ix. 21).

Circaëtus cinereus Vieill.

A female Brown Harrier-Eagle had snake scales in its stomach (Mtali's, 19. x. 21).

Kaupifalco monogrammica Temm.

The stomach contents of a One-streaked Hawk, shot at 7 a.m., were a gerbil (*Taterona vicina* ?) and a freshwater purplish crab, which (? the same one) I had encountered on the path at 4 p.m. yesterday (Kilosa, 19. ii. 21). A male had the skull and fur of a shrew (*Crocidura flavescens*) with many orthopteran remains and a few parasitic nematodes (Kilosa, 26. iv. 22). A very young Spotted Wood-Snake (*Philothamnus semivariegatus*) and grasshoppers comprised the stomach contents of another male (Kimamba, 7. iv. 23). Yet another male shot at 5 p.m. had a galeodes, a large locust, two praying mantids, and other insect remains. It had also two parasitic nematodes, identified by Dr. Baylis as *Physaloptera ? acuticauda* Molin (Kilosa, 6. v. 21).

ASTUR ? POLYZONOIDES Smith.

A female with ovules somewhat enlarged. In stomach, the fur and feet of a rodent that looked like *Mus bella* (Wami River, 9. ix. 21).

POLYBORIDES TYPICUS Smith.

Salimu shot a female Bare-faced Whistling Hawk in immature and interesting plumage. The primaries and two of the secondaries in each wing were brown, and there were quite a number of light brown feathers among the inner wing-coverts. The bare skin around the eye was light yellow, the base of the bill between lores pink, the bill itself black. Eyes black. Legs yellow. In its stomach was an adult lizard (*Zonurus tropidosternum*) (Kipera, 5. viii. 22).

CIRCUS MACROURUS Gmel.

A Grey Harrier was infested with lice and in its stomach were nematodes (*Physaloptera ? alata* Rud.) (Morogoro, 28. ii. 18).

VULTURIDÆ.

NECROSYRTES MONACHUS Temm.

A worm (*Thelazia depressa* Baylis, 1920) was taken from the eye of a Brown Vulture.

IBIDIDÆ.

THRESKIORNIS ÆTHIOPICA Lath.

Just after sunset some fifty Sacred Ibises came flying across the plains to roost in a big tree overhanging from the rocks. The tree is also occupied by a score or more *Corvus scapulatus* and probably as many *Milvus a. parasiticus* (Shanwa, 20. x. 22).

HAGEDASHIA HAGEDASH Lath.

My collector shot a female Great Glossy Ibis with a perfectly formed and coloured egg in its oviduct. This egg measured 51 × 46 mm., and was slightly greenish-white in ground-colour, spotted, blotched, or heavily smudged with brown. I told my boy to return and search the neighbourhood thoroughly for a nest, and this he succeeded in finding in a tree growing from a fissure in the rock-face about 20 ft. from the ground. It was very difficult of access, and was eventually reached by coming down the fissure in the rock-face, which only a native with bare feet could negotiate. He then removed his putties and, tying them together, lowered them to me. I tied a net on to these, and the two eggs were safely lowered one by one. They measured 55 × 42 and 61 × 42 mm. (Shanwa, 21. x, 22).

A male which was shot from a flock of three had the seed of a rubber-tree and a peculiar looking dipterous larva in its stomach (Kipera, 5. viii. 22).

Plataleidæ.

Platalea leucorodia leucorodia Linn.

The European Spoonbill was shot at Kilosa on 4. iv. 21, and its stomach contained the head of a large dragonfly (*Anax* sp.) and the plastron parts of a big beetle (? *Copris* sp.) together with a little green stuff. Its intestines were teeming with tapeworms (*Cyclorchida omalancristrota* (Wedl.)).

Platalea alba Scop.

An African Spoonbill was shot at Sagayo on 8. xi. 22 by my collector.

Ardeidæ.

Mesophoyx intermedius brachyrhynchus Brehm.

The stomach of a female Short-billed White Heron contained a frog and no parasites (Kilosa, 28. vi. 21).

Ardeola ralloides Scop.

The stomach of a Buff-backed Heron held insect remains and three nematodes identified as *Contracæcum microcephalum* (Rud.) (Kilosa, 29. vi. 21).

Ardea purpurea purpurea Linn.

The stomach of a male Purple Heron contained a house-rat (*R. r. alexandrinus*), several small fish, and a dragonfly with black bands on its transparent wings. Parasitic nematodes were *Contracæcum microcephalum* (Rud.) (Kilosa, 11. vii. 21).

Ardea cinerea cinerea Linn.

A male of the European Grey Heron was shot at Kilosa on 6. vii. 21. A female at Sagayo on 7. xi. 22. The latter was shot at 2 a.m. when it was fishing in a pool of the Shimiyu River.

BUTORIDES ATRICAPILLA Afzel.

Two eggs of the Green-backed Heron of a uniform pale green colour and measuring 34×28 mm. were brought me from a swamp by my collector. They were blowable, but had undergone considerable incubation (Kilosa, 5. vii. 21).

In the stomach of a specimen were worms identified as *Hymenolepis* sp. (near to *H. unilateralis* (Rud.)); in the intestines of the same bird was another nematode—*Contracæcum microcephalum* (Rud.) (Morogoro, 15. i. 18).

SCOPIDÆ.

SCOPUS UMBRETTA BANNERMANNI Grant.

The East African Hammer-head is known to the Wazigoor as "Mzeringee," the Wahehe as "Mgetu," the Wanyimwezi as "Mgenyi." A cock bird, shot while flying overhead this morning, had a frog and a shrimp and a number of parasitic nematodes (*Contracæcum microcephalum* (Rud.)) in its stomach (Mkata River, 25, viii. 21).

A nest was found in the fork of a tree leaning over a lagoon which was 200 yards long but rapidly drying up. The nest held four young within a week of being fledged, and they throve in captivity for six months, but died when transferred to Regent's Park. They would probably have died if left in the nest, as the surrounding ground was swarming with soldier-ants intent on destroying every living thing; many were already on the trunk of the tree (Mkata, near Station, 14. ix. 21).

CICONIIDÆ.

ABDIMIA ABDIMI Licht.

The Purple Storks always appear with the first rains, and are therefore known to many tribes of natives as the "Rain-birds." They have a peculiar way of circling in the air like a column of smoke, more particularly just before sunset. The stomach of a male examined contained centipede, grasshoppers, cockchafer, and three other species of beetles (Simbo-Ndala Road, 14. xi. 21). A great flock appeared at Sagayo camp during the first week in November 1922.

EPHIPPIORHYNCHUS SENEGALENSIS Shaw.

A male shot at Tindiga measured 6 feet 4 inches from tip of beak to tip of longest toe-claw and 8 feet 5 inches across the wings; the two fleshy lappets depending from the base of the lower bill are bright lemon-yellow, not "bright crimson" as stated by Stark and Sclater *.

I also saw Saddle-billed Storks at Kilamatinde and Kipera, but it is a scarce bird and goes singly or in pairs.

* Stark & Sclater, 'Fauna of South Africa,' vol. iv. p. 44, line 7.

Anastomus lamelligerus Temm.

The stomachs of a pair of Open-billed Ibis shot here contained some hard muscle-like lumps of matter, apparently from shellfish. No parasites were observed (Kilosa, 2. iv. 21).

Anatidæ.

Sarkidiornis melanotus africanus Hartl.

The Knob-billed Goose is very common here. An immature female shot to-day had down still mixed with its feathers. In the stomach and crop there was a large quantity of maize (Kilosa, 30. v. 21).

Colymbidæ.

Podiceps ruficollis capensis Salvad.

The following notes on the nidification of the Cape Grebe were all made on a small swamp or accumulation of temporary water which forms after the big rains and lasts about three months:—

Found a floating nest containing two dirty-white eggs (14. iv. 21). Revisited the nest at 5 p.m. on the 15th when there were three eggs, and again to-day when there were six. The hen bird appeared flapping about in the water in an attempt to decoy us away. Not far away I found another nest with four eggs (18. iv. 21). The bird, which laid four eggs and whose nest I robbed, laid a fifth egg yesterday on a few partly-submerged reeds which it had collected together for the purpose some fifty feet from the abandoned nest. To-day it laid its sixth egg in the deserted nest of another bird. The full clutch would appear to be six eggs (20. iv. 21).

A new nest with two eggs (22. iv. 21); five in this nest, and one of them partly incubated (25. iv. 21). A fourth nest found containing two eggs (25. iv. 21). The fourth nest held seven eggs, some fresh, some incubated. Shot what I thought to be the hen bird, but she had a pure-white egg in the oviduct measuring 36 × 24 mm. and two enlarged ovules in the ovary. The "colour" of this egg compared with the brown reed-stained ones in the nest was very striking (3. v. 21).

Revisited the swamp for the first time since 3. v. 21. One nest held two eggs. Two pairs of birds were swimming about with their young; their conduct was now very different; previously they had only splashed and dived to decoy one away, now they showed themselves boldly. From time to time one of the birds would utter a sharp whistling note, and having thus attracted attention, would dive with a splash; after a few moments the head would appear some distance off, and the cry would be repeated to lead one away from the young. These were entirely black, showing no rufous whatever; broken bits of shell were left in the nest from whence they came. It was a pretty spectacle to watch the old ones taking the young for rides on their backs, themselves semi-submerged (30. v. 21).

The nest, which held two eggs yesterday, had only one in it to-day, the other having hatched out, as was evidenced by the bits of shell left. The remaining egg had been carefully covered with grass, as is the custom with all but deserted eggs (31. v. 21). This egg still in the nest; another nest was found also with two eggs, uncovered and obviously deserted, as they had never been covered, being only stained on the lower surface. They were very fresh however (Kilosa, 1. vi. 21).

Two species of worms were found in the specimen shot, viz. (1) *Diœcocestus aspera* (Mehlis) and (2) *Hymenolepis* sp.

Rallidæ.

Gallinula chloropus brachyptera Brehm.

Three nests of the African Moorhen were found built in clumps of grass or reeds in deep water. The first had two eggs on 22. vi. 21, the second two eggs on 6. viii. 21, the third five eggs on the same date. Like the Common Moorhen's eggs, these show considerable variation in size, averaging about 41 × 30 mm.; the coloration is also identical with that of the English eggs and, like them, varies a good deal even in the same clutch, (Kilosa, *v. d.*).

Gallinula ? angulata Sund.

A single egg of the Lesser African Moorhen, measuring 43 × 31 mm., pale in colour with fine frecklings more like a coot's egg (Kilosa, 22. vi. 21).

Phasianidæ.

Numida coronata reichenowi O.-Grant.

Five eggs of Reichenow's Helmeted Guinea-fowl measuring 48 × 36 mm. were taken at Suna in February 1922 by my native collector.

Numida mitrata Pall.

The Coast Guinea-fowl is extraordinarily abundant between Mkata and the Wami River and at many other places in the Morogoro District. I have killed five with one shot, and a native killed eight with two on the path just outside the house (Kilosa, 4. viii. 22). Lice (*Goniodes numidæ* Mjöb.) were taken on a Kilosa bird on 11. iii. 1921.

Paridæ.

Phyllopezus africanus Gmel.

Bits of quartz and grass seeds in the stomach of a male African Jacana with large testes shot this day (Kilosa, 9. iv. 21).

MICROPARRA CAPENSIS Smith.

I shot a Pigmy Jacana from a flock of three seen on the swamp; its stomach contained insects; ovules large as if the breeding-time is near (Kilosa, 1. vi. 21).

CHARADRIIDÆ.

RHINOPTILUS CINCTUS CINCTUS Heugl.

A native brought me a Three-banded Courser cock which he snared as it returned to an egg which he had found buried in sand with only the top showing; the egg was well incubated. Heads of soldier-ants were found in the stomach of a female (Zengeragusu, 3. & 1. xi. 22).

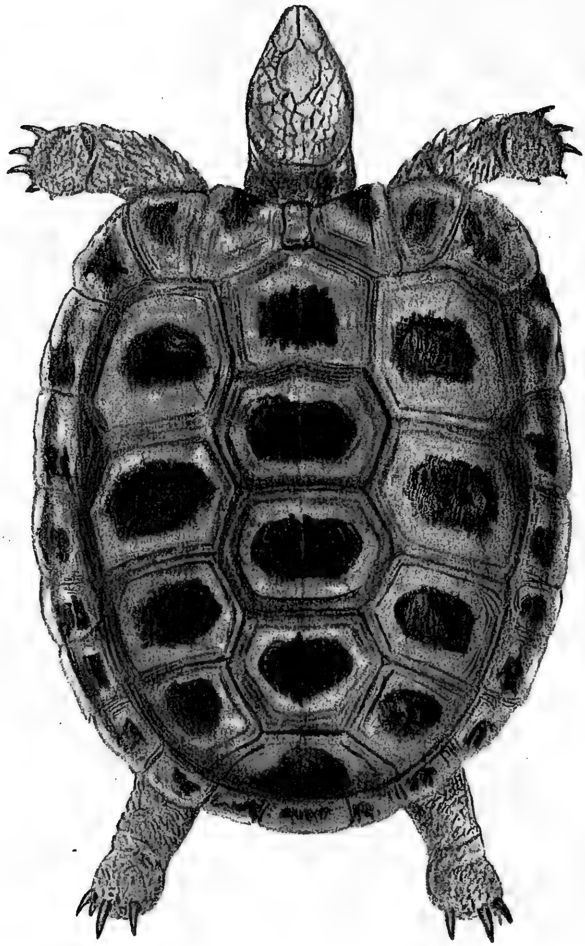
BURHINUS CAPENSIS CAPENSIS Licht.

A young Cape Spotted Stone-Curlew in down was brought me (Mdjengo's, 24. x. 21).

STRUTHIONIDÆ.

STRUTHIO CAMELUS MASSAICUS Neum.

As we were making camp a hen ostrich was to be seen some two hundred yards away casually feeding in the stubble of a mealie-field. Later I met it a mile away and carefully stalked it (without a gun). After I got within fifty yards my self-gratulation melted away, and when I was within twenty yards I felt sure the bird had some history. I enquired of an old man at a neighbouring kraal, and he told me that it had been in the neighbourhood for a year past, and was supposed to have strayed from a mission at Itigi (twelve miles away) where some had been reared. It lived all alone in the bush and came daily to the shambas to feed or be fed. "It will come if you call it," said he, and picking up an old maize cob from the ground, he held it out and called as one might call chickens, when, sure enough, the bird came running, but halted ten feet away on seeing that the object proffered was not edible. The old man said it would feed from one's hand if matama was held out to it (Mbonoa, 29. ix. 22).



Norman C. Miller.

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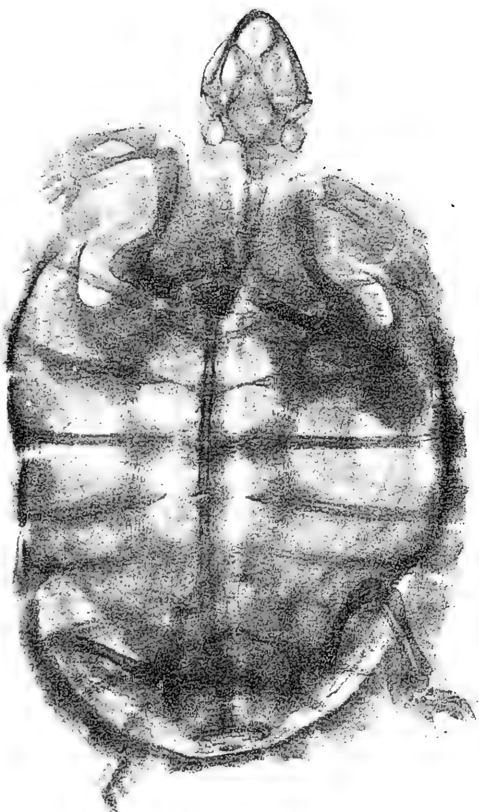
TESTUDO PROCTERÆ, sp. n.

(natural size of type which is not adult.)



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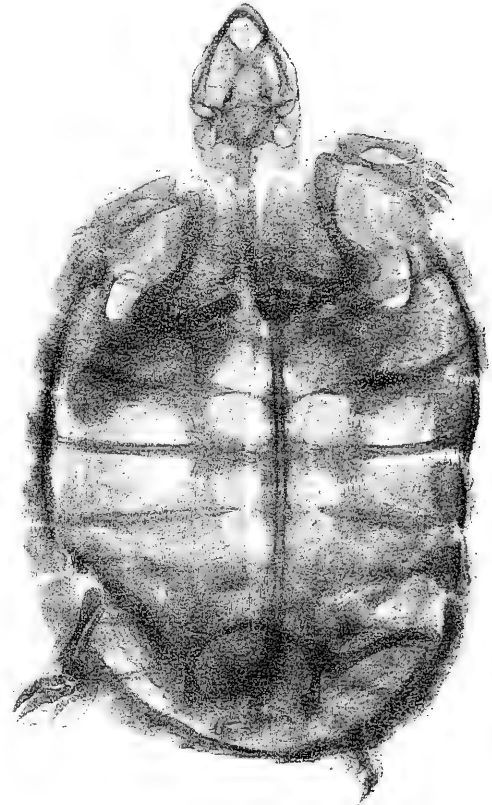

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John Bale, Sons & Danielsson, L^td

TESTUDO PROCTERÆ, sp.n.

45. Notes on East African Tortoises collected 1921–1923, with the description of a new species of Soft Land Tortoise. By Arthur Loveridge, C.M.Z.S., F.E.S.

(Plates I. & II.*)

[Received August 14, 1923: Read November 6, 1923.]

The hundred tortoises dealt with in these notes were all taken in Tanganyika Territory (formerly German East Africa) by my native collectors; not more than half-a-dozen were found by myself. They represent three of the four families known to inhabit Eastern Equatoria.

For the convenience of other herpetologists a key to the species recorded from this region has been added to these notes. It is largely adapted from keys in Dr. Boulenger's 'Catalogue of Chelonia in the British Museum,' 1889, with the recently described species incorporated.

Taking them from East to West, the localities mentioned in the following pages are:—

Morogoro District.—Turiani, Mkata River, Uliya, Myombo, Ruaha, Godegode.

Dodoma District.—Pwaga, Kidenge, Ikikuyu, Dodoma, Kissaki, Kilamatinde, Mbonoa, Singida, Mdjengo's.

Kondoa-Irangi District.—Mtali's, Zengeragusu, Ulugu.

Tabora District.—Tabora, Simbo, Tambali, Luguo, Wembere.

Mwanza District.—Sanga, Sagayo.

My thanks are due to Miss Joan B. Procter, F.Z.S., for advice and suggestions and the use of material in her charge, whilst writing up my field-notes. I have named the new species of soft-shelled land tortoise after her as some acknowledgment of her careful researches into the morphology and relationships of the strange group to which it belongs.

I am also indebted to Sir John Bland-Sutton for his gift of X-ray photos of the type which illustrate this paper and to Mr. Norman C. Miller, F.E.S., for making the water-colour drawing which forms the plate accompanying this article. Mr. Miller was staying with me at the time of the tortoise's decease and spared time from his work on the Orthoptera to make this sketch for me.

Mr. Stanley Hirst has also kindly named the few ticks found upon the tortoises. It is interesting to note that the four species of Testudinidæ, though coming from three widely separated localities, all bore the same tick, which I have never found on any other reptiles or mammals.

* For explanation of the Plates see page 933.

TESTUDINIDÆ.

CINIXYS BELLIANA Gray.

Blgr. Cat. Chelonians, 1889, p. 143.

More than fifteen specimens from Turiana, Mkata River, Uliya, Myombo, Kilosa, Ikikuyu, Pwaga, Godegode, and Simbo.

Bell's Hinged Tortoise is very common at Kilosa, both on the swampy grasslands of the lower ground and on paths in the maiombo bush on the hillsides. They can live in water for days without drowning, apparently resting on the surface without effort. I was given one by an Indian who had dropped it down a well two days before, where it was when I found it, none the worse for its experience.

In the Kilosa sub-district, where the country is of the open maiombo-bush type with rank grass growing between the bushes, the shells are much deeper than in the rock-strewn or dense thornbush country such as Pwaga, where the thornbush covers many miles with a thick and impenetrable mat; rocks were found in the valleys and scattered here and there upon the hill-sides, but those I came across did not seem to afford much cover for tortoises. The single Bell's Tortoise taken at Pwaga was very worn and depressed, as if it continually pushed its way beneath boulders. The Ikikuyu country is of a similar type to that at Pwaga, though there are more open, sandy, thornbush stretches on the low ground; the single specimen from this place was also depressed but not worn, the markings being distinct. Those from Simbo—similar country to Ikikuyu though a hundred miles or more west—were also worn and depressed, as has been remarked on elsewhere.

Locality.	Length.	Breadth.	Depth.	Depth.
Kilosa......	190 mm.	125 mm.	90 mm.	47·5 per cent.
Pwaga......	166 ,,	107 ,,	57 ,,	34·5 ,,
Ikikuyu ...	150 ,,	95 ,,	50 ,,	33·4 ,,
Simbo......	148 ,,	95 ,,	57 ,,	33·5 ,,
,, ...	145 ,,	95 ,,	57 ,,	39·4 ,,

My method of taking the depth was by placing the animal on its side between two blocks. Miss Procter measured with callipers at a given point, and as a depression in the plastron is frequent, our depths, and consequently depth per cent., are different, though both ways serve equally well to emphasise the depressed type of *Cinixys* inhabiting thornbush country.

The largest male (?) measured 190 × 125 × 90 mm. deep, the largest female 188 × 120 × 80 mm. The smallest example was taken at Uliya on 16. ii. 21, and measured 50 × 46 × 25 mm. It is somewhat abnormal in that it has twelve instead of eleven marginals on either side.

On two occasions I have found several score of Lesser Stink Ants (*Paltothyreus tarsatus*) in the tortoise enclosure worrying the reptiles. On the 23rd inst. two Bell's Tortoises were on their backs, and this morning another. This is either done in desperation or as a means of defence (24. ii. 22). Nevertheless, two were dead yesterday; the two which I had found on their backs, I believe (Kilosa, 26. ii. 22).

Though there was plenty of grass in their enclosure one of the tortoises was found to be eating hard maize corn; it would pick up one in its jaws five or six times and drop it, then apparently swallowed it whole. Another was found nosing a large yellow carpenter bee (*Xylocopa nigrita*) and was munching something at the time. One of the hind legs of the bee was missing, and the insect itself was very freshly dead, having probably fallen from the beams above. I watched the tortoise return again and again to the bee, but it never bit it. One knows the preference of the Greek Tortoise for yellow flowers such as dandelions and buttercups. Is it possible that anything of a yellow colour attracts tortoises?

To judge by some of the damaged shells on tortoises which have been brought me, these creatures can sustain very severe injuries to the carapace and the latter heal up.

It is the rule rather than the exception at Kilosa for Bell's Tortoises to carry some half-dozen ticks (*Amblyomma marmoreum* Koch), each adhering to the fleshy portions of the hinge of their shells.

TESTUDO PARDALIS Bell.

Blgr. Cat. Chelonians, 1889, p. 160.

Thirty-three specimens were collected from Pwaga, Mbonoa, Singida, Mdjengo's, Mtali's, Zengeragusu, Ulugu, Tabora, Simbo, Tambali, Luguo, Wembere, Sanga, Sagayo.

The Leopard Tortoise is frequently found in grassy steppe country where there are scattered bushes, but it is also commonly met with on kopjes, and often at a surprising height, as in the case of one whose skeleton was found between two sloping rocks at the very top of what was practically a mountain. One wondered how many years it had taken to reach the summit, seeing that the mountain was largely composed of piled-up boulders; this adventurous individual would appear to have met its death by sliding down the smooth sloping rock and being unable to clamber up again (Mtali's, 9. x. 22).

At Pwaga, where I was only camped for one afternoon, a local native brought (in addition to the depressed and worn *C. belliana* already referred to) no fewer than five Leopard Tortoises whose depth of shell was in no way less than those inhabiting grassy savannahs, though here they were in the same dense thorn-scrub as *C. belliana*. The range of sizes was so varied that they are worth quoting. The largest tortoise was a male; the others would appear to be all females. (1) 250 × 150 mm., (2) 130 × 85 mm., (3) 88 × 65 mm., (4) 70 × 56 mm., (5) 47 × 40 mm.

The largest male collected measured 312 × 210 mm. broad.

Pairing took place daily during the rains (December to January) amongst specimens in captivity. The process of egg-laying was witnessed on 21. v. 22, and the following notes were made at the time:—

"The tortoise enclosure measures 20 × 20 feet, two sides are high walls supporting the grass roof, the other sides are netted in. On visiting this enclosure at 5.15 p.m. I observed a tortoise busily digging with its hind legs. The selected site was the angle formed by wall and wire netting and a post which carried the latter. The hole was about six inches from both wall and netting.

"The ground was very hard, but she had already excavated to a depth of about two inches in a rough circle of about four inches in diameter. Digging was accomplished by inserting one hind foot which was scraped round and brought up with a very small quantity of soil on it, which often fell back into the hole at the last moment. Nothing like the quantity was lost that might have been, however, had not the tortoise discharged a quantity of urine from time to time, which resulted in binding the light powdery soil and caking it to her feet. Both hind feet were used alternately for digging, with occasional pauses between changing them.

"At 5.30 p.m. she began to undercut the sides all round by a turning movement of the foot so that the claws cut deeply into the sides of the hole in a semicircle; the back part, as far I could see, was not much affected.

"At 5.50 p.m. the hole was approximately four inches deep and retained its original diameter. The urine was not discharged as at first but continued to drip fairly regularly and almost continuously. By treading with her feet the soil was well puddled, and yet again and again the caked soil would fall from her foot just at the moment when she was clearing the brink of the crater, and thus rendered her work much more laborious.

"At 6 p.m. she scooped round and round the hole, which now measured almost five inches in depth.

"At 6.30 p.m. darkness fell, and an acetylene lamp was brought.

"At 7.12 p.m. the first egg was laid in a membrane which lowered it quite easily and gently to the bottom of the hole.

"At 7.14.50 p.m. the second egg slid slowly down the membrane which connects the first egg with the mother. Yet it did not fall on the first egg but lies alongside of it.

"At 7.15.50 she put her right hind foot down and pushed eggs slightly to one side causing them to grind one against the other; we therefore felt and found them to be perfectly hard-shelled when laid.

"7.17.50 third egg laid.

"7.19.10 fourth egg laid.

"7.21 put her left hind leg down and felt around, a fifth egg was laid about this time.

"7.22 a sixth egg was laid.

"7.22.50 put her right hind leg down and moved all eggs from the centre of hole to beneath the ledge of undercut.

"7.24.10 seventh egg laid, which appeared to be slightly smaller than its predecessors. I have omitted to mention that she raised herself slightly before depositing each egg.

"7.25 p.m. put down her right foot and pushed the eggs about quite forcibly till they lay in a semicircle, three-quarters of each egg being in the undercut.

"7.26.10 put down her left foot.

"7.27 put down her right foot.

"7.27.50 put down her left foot. It now became obvious that she was scraping down the sides of the crater, using her feet alternately.

"8 p.m. She now commenced a very definite treading movement with the object of pounding the soil. The action was very mechanical, and she dug two little pits with her hind feet to find sufficient earth to cover the eggs rather than utilise the earth already excavated which lay scattered about.

"Not once during three hours had she faced about to examine the result of her labours or inspect her own eggs, which she had buried without ever seeing. I was so struck by the mechanical nature of the proceeding that I picked her up and removed her a couple of feet away from the hole and on hard ground. There she continued trampling away without interruption—it was a sorry spectacle to see so much misplaced energy."

I replaced her over the original site and left her to trample it to her heart's content. In the morning she was resting motionless on the spot and remained so till I left at 9 a.m., how much longer I do not know. The next evening she returned and slept on the spot, and I noticed she did so many times, probably every night.

I had removed the fifth egg before she filled in the hole, and this measured $35 \times 32{\cdot}5$ mm. The shell was exceedingly hard, thin, and brittle, and took half an hour to drill. The albumen was turgid, coming forth in lumps. The yolk was an unpleasant ochre, very different from that of a fresh fowl egg.

On the 12th of June I made a note to the effect that, in addition to sleeping on the spot where her eggs were hidden, she relieves herself and makes her droppings on the site frequently, if not daily. I sent her away about the end of the month.

On July 8th it occurred to me that it might require her assistance for the young to escape from the "nest," as the surface of the ground above them had set as hard as cement. I therefore dug down to the eggs and found the top of the uppermost only $2\frac{1}{4}$ inches below the surface. They had not hatched, so I left them till 21. viii. 22, *i. e.*, three months from time of laying and then dug them all up. They had not developed embryos (so I conclude that they were infertile), nor had they decomposed beyond a slight smell.

In no fewer than six of the localities mentioned for this species, remains, generally of half-grown individuals, were found. One at Mbonoa had definitely been killed by a beast of prey or a man. The local natives (Wataturu) stated that they did not eat them, but this was probably untrue, as they ate agama lizards, rats, and other creatures.

The tick (*Amblyomma marmoreum* Koch) was found on a Pwaga specimen.

TESTUDO LOVERIDGII Blgr.

Blgr. C. R. Acad. Sci. Paris, 1920, t. 170, p. 264.
Love. Jour. E. A. & Uganda Nat. Hist. Soc. 1921, p. 50.
Procter, Proc. Zool. Soc. 1922, pp. 483–526.

Thirty-six specimens from Dodoma and Tabora; remarks on the habits of these have already been published as an appendix to Miss Procter's paper. A dozen of these tortoises escaped at Kilosa, and it will be interesting to observe if they survive the numerous carnivora without having any rock shelters under which they can seek refuge.

No ticks were ever found on wild specimens, the sandy soil of their habitat being unfavourable to these pests. A tortoise which escaped at Kilosa picked up a tick (*Amblyomma marmoreum* Koch) within twenty-four hours.

TESTUDO PROCTERÆ, sp. n. (Pl. I., II.)

? Two specimens from Ikikuyu and Kidenge in Dodoma District. The localities are about a hundred miles east of Dodoma, the type-locality of *T. loveridgii*. Ikikuyu, which is to be considered the type-locality of the present species, lies some fifty miles south of Igulwe (Gulwe) station on the Central Railway. The country is different from that of Dodoma in that there are no essentially rocky kopjes, though there are small hills with fairly numerous scattered boulders.

Within a mile of the spot where this specimen was found there are precipitous cliffs topping the mountains, and the slopes below are boulder-strewn and clothed with a dense thorn-bush thicket which is almost impenetrable. The more level country at the foot was, doubtless, similarly covered at one time but is now sandy thornbush steppe, amongst whose bushes the native-owned herds of cattle and goats wander. It was here that the tortoise was found eating a mushroom at 6 a.m.

Superficially it is very similar to *T. loveridgii*, but differs in the following points:—

(i.) Greater degree of ossification of the bony exoskeleton, particularly the carapace (the diamond-shaped fenestration of the plastron is similar to that of *T. loveridgii*).

(ii.) Greater depth of shell in proportion to length and breadth which may be best shown thus:—

Species.	Length in mm.	Breadth.		Depth.		Whereabouts.
		mm.	per cent.	mm.	per cent.	
T. loveridgii ...	85	77	90·5	19	26	Tring Museum.
T. procteræ ...	85	72	84·5	40	47	British Museum.

In the large series of *T. loveridgii* examined by Miss Procter the greatest depth per cent. of any specimen was 33·4 mm., and that was of the youngest example only 42 mm. long. The depth per cent. decreases with age, as has been shown by Miss Procter.

(iii.) Presence of a strong vertebral keel on all five scutes.

(iv.) Reversion of the marginals, which are turned up so that their outer edge forms an obtuse angle with their inner edge and in some an almost cup-like depression.

(v.) Coloration.—The centre of each scale is dark sepia, almost black, surrounded by a broad yellow margin; the star-like radiations of *T. loveridgii* are absent.

Owing to its immaturity it is impossible to say definitely that it might not be referable to the genus *Cinixys*, as the characteristic hinge of the carapace in that genus is not developed in young individuals. I am confident that it is correctly assigned to the genus *Testudo*. *C. belliana* was taken at Ikikuyu on the same day as *T. procteræ*, and though depressed the ossification is fully developed. *T. tornieri*, it may be remembered, was originally mistaken for a pathological phase of *C. belliana* by Tornier *.

T. procteræ I consider to be one stage nearer the typical box tortoises than *T. tornieri*.

Sex ?. Half-grown.

Type-locality. Ikikuyu, Dodoma Dist., Tanganyika Territory, 12. ii. 23.

This specimen was kept alive for three months in captivity, but unfortunately died, and decomposition had set in when it was found. The reptile was immediately preserved, but in poor condition. It has been presented to the British Museum.

The second specimen was found beside a small stone at the foot of a rock-strewn, scrub-covered mountain (Mt. Hundugula) at Kidenge. It was so young that I hesitate to refer it definitely to this species, excepting on the grounds of locality, as it was not twenty miles from Ikikuyu. It measured 40 × 37 × 17 mm. (greatest length, breadth, and depth of shell), and was taken back to Kilosa, where it was left in charge of a native who lost it in cleaning out the vivarium. So rarely are these creatures met with that the local chief said that during the thirty years of his residence he had never heard of a tortoise being found in the neighbourhood.

A tick (*Amblyomma marmoreum* Koch) was on the type-specimen when found.

* Tornier, Kriechtiere Deut. Ost-Afrikas, 1897, p. 2.

Chelonidæ.

Chelone mydas Linn.

Blgr. Cat. Chel. 1889, p. 180.

A carapace was obtained from fishermen at Dar es Salaam in 1922; these turtles are caught fairly frequently. A live one was seen alongside the ship in Tanga Harbour (27. v. 23); it thrust its head out of the water close alongside us, and could be seen to advantage as it swam about.

Pelomedusidæ.

Pelusios nigricans (Donnd.).

Blgr. Cat. Chel. 1889, p. 195.

Three specimens from the Ruaha, Kilosa, and Kissaki in Dodoma District. These were adult, half-grown, and immature respectively, the smallest measuring $47 \times 40 \times 13$ mm.

Pelomedusa galeata (Schoepff).

Blgr. Cat. Chel. 1889, p. 197.

Ten specimens from Dodoma, Mahaka, Kilamatinde, Mtali's, and Luguo.

Of these the largest male weighed 2 lbs. and measured $200 \times 135 \times 68$ mm., the largest female $142 \times 112 \times 29$ mm., and a very young one from Mahaka on 10. iii. 22, measured $49 \times 39 \times 18$ mm.

After two heavy rainstorms on the two preceding days, which heralded the advent of the rainy season, a *P. galeata* was found at 8.15 a.m. busily engaged in trying to dig itself into the middle of a sandy road. The rains had doubtless disturbed it and caused it to wander. (Mtali's, 20. x. 21).

My wife reported having seen a Lesser Stink Ant (*Paltothyreus tarsatus*), which had fallen into the water-tank, seized by one of these tortoises. This is remarkable, as the ant has a formidable sting, as well as good jaws and a protective smell. We therefore experimentally introduced three more, which were taken without hesitation by the tortoises, who snapped them in half. The head and thorax were first crunched up and then the abdomen picked up and eaten. Grasshoppers and spiders were also taken, one of the latter being warningly coloured in black and yellow.

A Key to the Tortoises of Tanganyika Territory, Kenya Colony, and Uganda.

Synopsis of the Families.

I. Shell covered with epidermal, horny shields.
  A. Pectoral shields of plastron in contact with the marginals.
    1. Plastral shields 11 or 13 .... Testudinidæ.
    2. Plastral shields 12 as intergular present.................... Pelomedusidæ.
  B. Pectoral shields widely separated from the marginals; limbs paddle-shaped, with one or two claws.............. Chelonidæ.
II. Shell without epidermal shields .... Trionychidæ.

TESTUDINIDÆ.

Two genera.

Synopsis of the Genera.

Posterior portion of carapace hinged, movable in adult .... *Cinixys.*
Posterior portion of carapace immovable .... *Testudo.*

CINIXYS.

Bell, Tr. Linn. Soc. xv. p. 398 (1827); Blgr. Cat. Chel. p. 140 (1889).

One species.

1. CINIXYS BELLIANA Gray. Bell's Hinged Tortoise.
Blgr. *t. c.* p. 143.
Tanganyika Territory, Kenya Colony, Uganda.

TESTUDO.

Testudo, part., Linn. S. N. i. p. 350 (1766); Blgr. Cat. Chel. p. 149 (1889).

Four species.

Synopsis of the Species.

I. Shell deep, box-like .... *pardalis.*
II. Shell depressed, yields to slight pressure.
A. Vertebral shields keeled .... *procteræ*
B. Vertebral shields not keeled.
1. Narrower. Breadth of plastron three-quarters the length in the type.. *tornieri.*
2. Broader. Breadth of plastron greater than length in young to 13/16ths in adult.. *loveridgii.*

1. TESTUDO PARDALLIS Bell. Leopard Tortoise.
Blgr. *t. c.* p. 160.
Tanganyika Territory, Kenya Colony, Uganda.

2. TESTUDO PROCTERÆ Loveridge. Keeled Soft-shelled Tortois e.
Love., present paper.
Tanganyika Territory.

3. TESTUDO TORNIERI Siebenrock. Tornier's Tortoise.
Sieb. S.B. Ak. Wiss. Wien, vol. cxii. p. 443, 1903.
Tanganyika Territory, Kenya Colony.

4. TESTUDO LOVERIDGII Boulenger. Soft-shelled Land Tortoise.
Blgr. Comptes Rend. Acad. Sci. t. 170, p. 264, 1920.
Tanganyika Territory.

PELOMEDUSIDÆ.

Two genera.

Synopsis of the Genera.

Mesoplastra extending right across the plastron; front lobe of plastron movable in the adult .... *Sternothærus.*
Mesoplastra small and lateral; front lobe of plastron without hinge in adult .... *Pelomedusa.*

STERNOTHÆRUS.

Sternothærus, part., Bell, Zool. Jour. ii. p. 305 (1825); Blgr. Cat. Chel. p. 191 (1889).

Three species. (*S. sinuatus* and *S. nigricans* doubtfully distinct and difficult of determination.)

I. Beak notched mesially, with a very slight, obtuse cusp on each side of the notch; interorbital width considerably less than the longitudinal suture between the frontal shields .... *sinuatus.*
II. Beak neither hooked nor bicuspid; frontal suture not or but slightly exceeding the width of the interorbital space.
  A. The length of the outer border of the pectoral shields equals that of the humeral .... *nigricans.*
  B. The length of the outer border of the pectoral is much less than that of the humeral, and does not exceed the length of the inner border of the latter shield .... *derbianus.*

1. STERNOTHÆRUS SINUATUS (Smith). Smith's Water Tortoise.
Blgr. *t. c.* p. 194.
Tanganyika Territory, Kenya Colony, Uganda.

2. STERNOTHÆRUS NIGRICANS (Donnd.). Black Water Tortoise.
Blgr. *t. c.* p. 195.
Tanganyika Territory, Kenya Colony, Uganda.

3. STERNOTHÆRUS DERBIANUS (Gray). Derby's Water Tortoise.
Blgr. *t. c.* p. 195.
Uganda.

PELOMEDUSA.

Wagl. Syst. Amph. p. 136 (1830); Blgr. Cat. Chel. p. 197 (1889).

One species.

1. PELOMEDUSA GALEATA (Schoepff).
Blgr. *t. c.* p. 197.
Tanganyika Territory, Kenya Colony, Uganda.

CHELONIDÆ.

Two genera.

Synopsis of the Genera.

Costal shields in four pairs .... *Chelone.*
Costal shields in five or more pairs .... *Thalassochelys.*

Chelone.

Chelonia, part., Brongn. Bull. Soc. Philom. ii. p. 89 (1800).
Chelone Blgr. Cat. Chel. p. 180 (1889).

Two species.

Synopsis of the Species.

Carapace unicarinate in young. Limbs usually with a single claw ... *mydas.*
Carapace tricarinate in young. Limbs usually with a double claw ... *imbricata.*

1. Chelone mydas (Linn.). Green Turtle.
Blgr. *t. c.* p. 186.
Tanganyika Territory, Kenya Colony.

2. Chelone imbricata (Linn.). Hawksbill Turtle.
Blgr. *t. c.* p. 183.
Tanganyika Territory, Kenya Colony.

Thalassochelys.

Fitz. Ann. Wien. Mus. i. p. 121 (1835); Blgr. Cat. Chel. p. 184 (1889).

One species.

1. Thalassochelys caretta (Linn.). Loggerhead Turtle.
Tanganyika Territory, Kenya Colony.

Trionychidæ.

One genus. (*Cycloderma* in neighbouring territories.)

Trionyx.

Trionyx, part., Geoffr. Ann. Mus. xiv. p. 1 (1809); Blgr. Cat. Chel. p. 242 (1889).

1. Trionyx triunguis (Forskal). Freshwater Soft-Tortoise.
Victoria Nyanza.

EXPLANATION OF THE PLATES.

Plate I.

Type of *T. procteræ*, sp. n., from a water-colour drawing made after death.

Plate II.

Type of *T. procteræ*, sp. n., dorsal and ventral views from X-ray photographs.

46. Notes on East African Lizards collected 1920–1923, with the Description of two new Races of *Agama lionotus* Blgr. By Arthur Loveridge, F.E.S., C.M.Z.S.

[Received October 3, 1923: Read November 6, 1923.]

The following notes are based on a collection of lizards and chameleons collected by the writer during six months in Kenya Colony (formerly British East Africa) and two and a half years in Tanganyika Territory (late German East Africa).

Representatives of all the families of East African Lizards were again collected (with the exception of Anelytropidæ), more than half the genera and a little more than one-third of the species. The numbers are distributed as follows:—

Family.	*Genera.*	*Species.*	*No. of Specimens.*
Geckonidæ	4	11	92
Agamidæ	1	5	128
Zonuridæ	1	1	2
Varanidæ	1	2	7
Amphisbænidæ	1	1	2
Lacertidæ	5	7	249
Gerrhosauridæ	1	2	4
Scincidæ	4	12	119
Chamæleontidæ	1	7	42
		Total...	645

Of the forty-eight species, however, no less than seventeen were collected by the writer for the first time and of these two were undescribed. Particular attention is directed to such rarities as *Pachydactylus boulengeri, Geocalamus modestus, Algiroides alleni, Mabuia irregularis, Mabuia obsti,* and *Melanoseps ater* var. *longicauda.* Several of these species have only been known from the types hitherto.

Taking them from east to west and south to north, the principal localities mentioned in the following pages are:—

Kenya Colony.

Kilindini, Mombasa Is., Frere Town, Voi, Nairobi, Eldoret, Kisumu, Karungu Bay.

Tanganyika Territory.

Dar es Salaam District.—Dar es Salaam.

Morogoro District.—Bagilo, Mt. Kirui, Mkindo River, Wami River, Mkata River, Ilonga, Kimamba Station, Tindiga, Kipera, Kilosa, Kidai, Kidete, Kisanga, Mbala.

Dodoma District.—Lukole, Ikikuyu, Mpanira-kwa-Sagoi, Kidenge, Itende, Pwaga, Igulwe, Dodoma, Kilamatinde, Mbonoa, Ndogwe, Suna, Gwao's, Mbulu's, Pooma, Singida, Mdjengo's.

Kondoa-Irangi District.—Mtali's, Mkalama, Usshora, Ulugu.

Tabora District.—Tabora, Izikisia, Ndala, Tambali, Luguo.

Mwanza District.—Sanga, Lalago, Mwadira, Shanwa, Sagayo, Nyambita, Mwanza.

Bukoba District.—Bukoba, Kabare.

The determinations and draft of this paper were made in East Africa, but three days were spent in going over them again at the British Museum, where I had the advantage of comparing my specimens with allied forms in the National Collection. In this connection I would like to express my most grateful thanks to Miss Joan B. Procter, F.Z.S., for much help in examining dubious determinations and for making notes for me on specimens sent home.

I have given varietal names to two Agamas to emphasise their very distinctive colouring. One of these forms I have already referred to in a previous paper.

As before* measurements are given to the nearest eighth of an inch followed by the exact measurements in millimetres of the length from snout to vent, followed by the tail length when intact; reproduced tails are denoted by an "r". Maximum lengths are only given when these exceed those recorded in the previous collection.

Once again I am indebted to Dr. H. A. Baylis, F.Z.S., for carrying out the determinations of parasitic nematodes found in so many tropical lizards.

GECKONIDÆ.

HEMIDACTYLUS MABOUIA Mor.

Blgr. Cat. Liz. i. 1885, p. 122.

A further large series of forty-five specimens of the House Gecko were collected from the following fresh localities:—Zanzibar, Bagilo, Mkindo, Ilonga, Kilosa, Mbala, Mt. Hundugula at 1200 feet, Itende, Kilamatinde, Mkalama, Kisumu, Frere Town, and Mombasa Is.

Mjusi kafiri is the Kiswahili name for this species. Kololo-lumbusi in Kigiriama according to Koch.

On Mombasa Is. a series was taken on baobab trees, where they attain to a greater size than in houses, in such situations it is exceptional to meet with them less than 80 mm. in length from snout to vent. I am disposed, therefore, to think that they desert houses as they grow older and take to trees. But the eggs are common enough in fissures of the bark, though the young are

* Loveridge, "Notes on East African Lizards collected 1915–1919," Proc. Zool. Soc. 1920, pp. 131–167.

only occasionally met with, so if my theory is correct the young must find their way back to the houses. Young specimens are commonly met with in rubbish heaps or accumulations of vegetable matter in waste land near houses. Examples caught on bushes are olive-green in colour when found and look very distinct.

The chin shields of the present series show considerable variation; normally only the first pair are in contact behind the mental, sometimes the second pair are also, again in one Mombasa specimen the shields forming the second pair are transversely divided. There is little profit in discussing the abnormalities of a species whose wide variation is evidenced by the dozen names under which it has been described from time to time.

I wonder whether it is generally known that daylight can be seen through a gecko's head if the ear-openings happen to be in line with the light. A gecko used to lie on a certain bar just at sunset at Kilosa, so I had the opportunity of seeing this phenomenon many times.

A six weeks old gecko measured 45 mm. over all; only one of the present series was longer than those recorded from my previous collection, and the tail was unfortunately reproduced (87+60 r), so that over all it was not greater. This fine specimen came from Bagilo in the Uluguru Mtns.

A Frere Town specimen had a bifid tail, the regenerated portion being the longest (52+56 & 59). A gecko with only three legs was seen several times at Kilosa.

The following note on mating was made at Kilosa 1. vi. 21.:—"Whilst working by lamplight at 7.10 p.m., I heard a noise 'tchk, tchk,' and looking up, saw two large geckos on the outside of the mosquito gauze which enclosed the verandah. One had seized the other by the right side of its neck apparently just at the moment my attention was attracted, a second later there was a rapid movement as the posterior portions of their bodies met and pairing took place. Moving the lamp possibly scared them, for they separated a minute afterwards, running away in different directions."

It seems probable that eggs are laid at all times of the year, for besides March, July, October, December already recorded, a pair of eggs were found in a lock at Frere Town on 2. viii. 20, five beneath an earthen pot at Kilosa on 13. v. 22, twenty beneath a pile of rotting palm-leaves at Dar es Salaam on 4. xii. 22, five beneath logs at Mbala on 26. ii. 21; also at Dar es Salaam and Frere Town on v. 23. The Kilosa eggs hatched on 20 and 21. v. 22, and nine of the Dar es Salaam eggs within a fortnight of being collected.

Dietetic records are best described from my notes direct:—

"Shot a gecko on trunk of palm-tree with a polydesmid in its mouth." (Zanzibar, 19. xi. 20.)

"A half-grown gecko captured a tsetse (*Glossina morsitans*) on mosquito-gauze of the verandah." (Kilosa, 1. xii. 20.)

"A large mantis was resting on the outside of the gauze in bright sunshine at 3 p.m. when a gecko darted upon it, but the mantis managed to elude it and escape." (Kilosa, 5. v. 21.)

"At 7.45 p.m. I was sitting at work when I heard a sharp rapping at the far end of the verandah which sounded precisely like the hammering of a rat's tail when trapped, the volume of sound being quite as large. On reaching the spot however, I found it was a large gecko which had swallowed the greater part of a centipede, but three-eighths of an inch remained in view together with the caudal appendages. Disturbed by the light, the gecko paused for a minute, then commenced spasmodically hammering the side of its jaw on the wooden panelling, and then disgorged two inches of the centipede, which I judged by the breadth to be about three inches long. It rested for a while with this object hanging limp and motionless from its mouth except for giving it an occasional knock. Presently it ran up a post and along the spouting of the gutter, where with a few gulps it re-swallowed the whole. From the time I became a spectator till all was over was something like ten minutes." (Kilosa, 14. vi. 21.)

"Hearing a gecko thumping some object against the wall outside, I found it to be a large cricket. To prove what a noise they can make against a stone wall, I measured the distance from the scene of the combat to where I had been sitting and found it to be 23 feet." (Kilosa, 9. vii. 21.)

"A fly (*Negritomyia maculipennis*), which is an excellent mimic of one of our wasps, was crawling on a white and lighted ceiling at 8 p.m., when I observed a gecko stalking it. When the gecko was just about the right distance for a spring the fly gave a buzz, and the lizard, after studying it a moment longer, withdrew." (Kilosa, 1 i. 22.)

"At sunset I observed a gecko on the gauze facing upwards to a large blue hornet, the hornet adopted a menacing attitude and then flew a few inches up the gauze and again settled, the gecko ran after it but halted an inch away and did not attack." (Kilosa, 29. i. 22.)

"Hearing a hammering a few nights ago, I ran out to find a gecko with a large male siafu or soldier ant." (Kilosa, 31. i. 22.)

"A gecko was hammering a black field cricket this evening." (Kilosa, 11. iii. 22.) I might add here that a Mombasa gecko had a cricket in its stomach, and a Dar es Salaam specimen disgorged one when caught.

"My attention was drawn to a gecko which seemed to be struggling with something on the ground. On fetching a light it was found to be flinging itself about and squirming over in an attempt to rid itself of a solpugid (*Solpuga darlingi*) which was holding the gecko in its jaws, having hold of the head between eye and ear. The skin was all gone from this area and there were signs of bites on the right side and near the base of the tail. I surmise that the gecko had first attacked the solpugid, but the latter would certainly have killed the gecko, which already had a large black field-cricket in its stomach." (Kilosa, 12. iv. 22.)

A spider, moth, and acridian were in the stomachs of Mombasa and Frere Town specimens. It is strange that some people still kill these useful little lizards on mere grounds of dislike.

They do not appear to have many enemies. I caught a Spotted Wood-Snake (*P. semivariegatus*) in the act of swallowing one in the fowl-house, and the gecko had not dropped its tail. A month later I caught another Spotted Wood-Snake, and when placed in the vivarium it disgorged a bolus of one of these geckos which also had its tail intact. One was found in the stomach of a Monitor (*V. niloticus*).

When large numbers of these geckos live in a house it is quite a remarkable sight to see them leaving it at sunset to go foraging; they descend the walls from the eaves, and should there be shrubs or tree-trunks within a foot or so, they reach them by a leap. The natives put their own interpretation on these nocturnal expeditions however, and informed me it was evidence of the creatures' shrewdness, as they feared to remain in the house after dark lest a careless person should set it on fire!

According to Koch's Vocabulary the natives say this lizard dislikes man, and requests that God will destroy him in order that the gecko may not be disturbed whilst eating sand.

Hemidactylus squamulatus Torn.

Torn. Die Kriechtiere D. O. A. 1897.

One male and three females were collected at Kilosa on open grass-free ground after dark; two were seen by the light of a lantern as I was returning home, and the third was about nine inches away from a giant field-cricket which was shrilling in a most deafening manner. I wondered if the gecko was dazed by the noise as it made no attempt to escape when approached.

Male measured 45 mm. + r, the largest female measured $4\frac{1}{4}$ inches (67 + 40) and had two enlarged ovules in its ovary over 2 mm. in diameter (13. vii. 21).

The colour in life was pale reddish brown above with an irregular network of brown lines on the body, and less distinctly on the tail. The posterior end of the enlarged tubercles was cream-coloured, very noticeable on flanks. A remnant of an eye-streak is to be found in a small dot in front of eye and a faint streak behind. Another specimen was dark nut-brown.

Hemidactylus citernii Blgr.

Blgr. Ann. Mus. Gen. (3) v. 1912, p. 329.

Six specimens from Mbala, Lukole, Kidenge, and Itende, where they were taken beneath stones on rock-strewn hillsides or, in a couple of instances, beneath logs. These records extend our knowledge of the southerly distribution of this Somali species considerably.

The male referred to in my last paper has 7–7 upper labials and 5–6 lower labials.

The largest male measured $2\frac{7}{8}$ inches (36+37 mm.). It is a pale brown in life with darker brown spots tending to form cross-bars. Eyelids yellow, a good deal of yellow on labials, many of the tubercles yellow.

Examination of stomachs negative.

HEMIDACTYLUS BROOKII Gray.

Blgr. Cat. Liz. i. 1885, p. 128.

Five examples from Mkata River, Bukoba, Karungu Bay, Kisumu, and Mombasa. One was dug from a termite hill and others were found beneath boulders on the shore of Lake Victoria. The female from Kilindini was beneath a tin near the shore.

One of these had 8–7 upper labials and only 6–6 lower. A male larger than any I had taken before measured $4\frac{1}{2}$ inches (65+52), and came from Mkata.

Both those from the termite hill and the boulders were quite black when found but rapidly changed after capture.

Eggs, laid in pairs, were found beneath boulders and measured 11 × 10 mm. One examined was found to contain a well-advanced embryo (Karungu Bay, 16. xii. 22).

There is often considerable difficulty in distinguishing this species from *H. ruspolii*, but an examination of a series of each in the British Museum shows that whereas *H. ruspolii* has the head covered with plates more or less equal in size and generally keeled, the head of *H. brookii* has enlarged, keeled, oval shields scattered amongst very small granules which cover the greater part of its surface.

LYGODACTYLUS FISCHERI SCHEFFLERI Sternf.

Sternf. Ergebn. Deutsch-Zentr.-Afr. Exp. 1918, iv. 2, p. 206.

A single male from Bagilo, Uluguru. It only differs from the description of the type in having a lower number of præ-anal pores—5 instead of 6—and in the under surface being profusely spotted except in the centre of the abdomen, as against "Underparts pure white, at the most a few little brown spots on the chin-shields" (translation).

LYGODACTYLUS GROTEI Sternf.

Sternf. S.B. Ges. naturf. Berlin. Nr. 4, 1911, p. 245.

Five specimens from Kilosa, Itende, and Igulwe.

A male captured on a stump in a rubber plantation at Kilosa was coloured as follows:—"General colour grey. A blackish stripe commencing at nostril passes through eye and almost vanishes on groin though continued faintly on base of tail. Three pale spots on line on flank. A second black spot on canthus rostralis (forming with its fellow a Λ mark on snout) passes above eye and breaks up into two lines dorsally which vanish in lumbar region. Tail reddish with faint greyish mottlings dorsally."

Two eggs (7 × 6 mm.) probably of this species were taken at Pwaga near Itende. Termites in stomach of Itende specimen.

LYGODACTYLUS PICTURATUS Peters.

Blgr. Cat. Liz. i. 1885, p. 161.

Seen at Mkindo River, Mkata Stn., Kimamba Stn., Kilosa, Kipera, Madazini, and Kidete. I had fired at a tree some 200 yards away at Kipera, and on reaching the spot picked up the gecko, which had apparently been killed by the concussion of the rifle-bullet as it penetrated the tree.

A male was found in a most unlikely place, viz. deep down in a termite's nest; in colour it was quite black, but soon regained its characteristic yellow head when exposed to the light.

Two eggs measuring 5 × 6 mm. were found in a rotting pile of palm-leaves at Dar es Salaam, 4. xii. 22, but did not hatch.

A gecko of this species was found in the stomach of an owl (*Glaucidium capense scheffleri*), Wami River, 3. ix. 21, and in the stomach of a snake (*Amplorhinus nototænia*), Mkata River, 24. viii. 21.

Thirteen specimens of the Frere Town var. were again collected at that place and also at Kilindini on Mombasa Is. As previously mentioned, the typical yellow-headed form was collected on the Island in 1919, but a very thorough search for it proved negative, and as it was caught at the station I imagine it was introduced.

The largest male measured 3 inches (37 + 40) and female $2\frac{3}{4}$ inches (39 + 40), being larger than the last record in body length only, the tail being reproduced.

PACHYDACTYLUS BOULENGERI Torn.

Torn. Kriechtiere D. O. A. 1897, p. 26.

A single female collected near a dry watercourse on the Sagayo road some fifteen miles west of Mwanza about 1 a.m. on 13. xi. 22.

Except for the blunter snout this gecko is superficially very like *H. mabouia*, particularly in colour and markings. On closer examination the feet of course are very dissimilar. This female measured $2\frac{7}{8}$ inches (45 + 29).

PACHYDACTYLUS BIBRONII Smith.

Blgr. Cat. Liz. i. 1885, p. 201.

Eighteen specimens from Igulwe and Dodoma.

The largest male measured $4\frac{5}{8}$ inches (60 + 56) and female $3\frac{7}{8}$ (51 + 46). One Igulwe specimen had a large cricket in its stomach, the other five were gorged on termites.

Elasmodactylus triedrus Blgr.

Blgr. Rev. Zool. Soc. Afr. iii. 1913, p. 104.

Three specimens of this rare Congo Gecko were obtained at Suna, in Singida, where they occur on the stems of the Bussu Palms, where there is abundant cover for them among the branch-stalks and fibre.

The Wanyaturu call them Mwenkenyo and say that they inhabit houses also, and when they groan someone falls sick. I thought at first they were confusing it with *H. mabouia*, but later saw *E. triedrus* come out of the thatch of the hut I was occupying and move down the wall to the entrance of a termite's nest in the floor, into which it vanished!

The largest of these males measured $5\frac{7}{8}$ inches (67+82) and the others 63+70 and 61+r.

One specimen had a plant bug in its stomach.

Agamidæ.

Agama hispida var. distanti Blgr.

Blgr. Ann. & Mag. N. H. (7) ix. 1902, p. 339.

The Wanyaturu, who have specific names for the various lizards, call this one Lukhumbeli, and the Wanyiramba name is Kimandagala.

Forty-three specimens were collected from Dodoma, Mbonoa, Suna, Gwao's, Mtali's, and Mkalama in Tanganyika Territory and Delagoa Bay in Portuguese East Africa (1914). This active little Agama is essentially an inhabitant of sandy thorn-bush country, and though rocks may be abundant as at Gwao's, it leaves these to *A. lionotus* in the main and itself takes to trees if chased. The five P. E. A. specimens were taken as follows:—Two in sandy thorn-bush, one forty feet up a tree in the same locality, one on a fence, and one under a heap of garden rubbish.

The largest male measured $8\frac{1}{2}$ inches (93+125), and female $7\frac{1}{4}$ inches (93+91). A young one taken at Delagoa Bay on 24. xii. 14, measured just over $2\frac{1}{8}$ inches.

The soil of Delagoa Bay being reddish the lizards harmonized with it most wonderfully, nor did their colour fade on preservation to any great extent, for nine years afterwards they are chestnut-brown and very different from the sandy-coloured form from Gwao's. Colour notes made at time of capture read: "Body colour brick-red and brown, a cream-coloured dorsal line extends from the parietal scale to beyond the hind limbs where it merges into the cream shading of tail. Two of the smaller specimens had bluish heads and a large blue gular spot surrounded by longitudinally arranged series of smaller spots. Ventral scales also brick-red."

Gwao's specimens were very different. Male: "Above sandy or greyish fawn. A sienna-brown speck about centre of canthus rostralis, two slightly V-shaped sienna-brown lines across crown between supraoculars. Similar markings, often interrupted on the vertebral line, along back and tail. Four on back and nine on tail and a very U-shaped one on nape. A few faint marks on limbs. Below pure white excepting throat, which is dirty white with eight longitudinal blue lines, and a large blue patch on basal portion of throat."

One female was uniformly sandy-buff, with only very faint traces of the sienna markings of the male here and there. Uniformly white beneath, the blue vermiculations found on the throats of males are only faintly discernible on close investigation. Another type of female had a reddish-brown ground-colour. Crown of head dull bluish-grey with two very distinct cross-bars uniting the supraocular regions. Cheeks bright ultramarine. Throat cream-coloured with rusty vermiculations and slightly discoloured basal spot. Rest of under surface whitish. A slight cream dorsal stripe from occiput to halfway along the tail bordered at intervals by sepia blotches, of which there are five pairs on body and ten pairs on tail.

One of my specimens has the occipital not enlarged.

Miss Procter observes that many lack the light vertebral line and in some the ventral keels are marked, both of which are features distinguishing *A. distanti* from *A. hispida*. I therefore consider that *A. distanti* is not a distinct species but only a geographical race of *A. hispida*.

Large white crickets were taken from the stomachs of two specimens, ants were commonly met with, and once a ? glow-worm.

One of these lizards was found in the stomach of a Roller (*Coracias nævia*).

At Gwao's they are commonly afflicted with a parasitic worm which proved to be a new species (*Physaloptera gigas* Spaul), and also *Strongyluris brevicaudata* Müller.

AGAMA MOSSAMBICA Peters.

Blgr. Cat. Liz. i. 1885, p. 363.

Four specimens from Kilosa, Izikisia, Ndala.

An immature male from Kilosa had 70 scale-rows, Izikisia specimens 75, and the Ndala female 84. The ear-opening of the last-named specimen was *not* "much larger than the eye-opening"; its third and fourth toes *equal*, also fifth toe *not* extending beyond the first. Tail *not* twice as long as distance from gular pouch to vent, the distance being 60 mm. and tail length 100 mm. In some specimens from Nyasaland in the British Museum the ventrals are unkeeled, and in others from the same locality they are keeled.

The largest male measured $10\frac{1}{8}$ inches (93+165), and female $7\frac{3}{8}$ inches (85+100).

In the immature male from Kilosa there is a brilliant blue upper labial streak, and a blue band across in front of the eyes from side to side, a network of faint blue lines on the throat and a darkish patch in front of the shoulder.

There were thirteen large ovules (13×8 mm.) in the ovary of a specimen collected at Ndala on 15. xi. 21.

Amongst stomach contents were the remains of a scorpion, a grasshopper, and what appeared to be ants though they were much crushed.

AGAMA LIONOTUS var. DODOMÆ, var. n.

Known to the Wanyaturu as Khombele and the Wanyiramba as Kinsuku.

Thirty-five specimens were collected of the Dodoma var. at Kidai, Kidete, Pwaga, Kidenge, Ikikuyu, Dodoma, Ndogwe, Gwao's, Pooma, Mdjengo's, Mtali's, and Izikisia, and what were believed to be this form were seen at Mkindo River and Kilamatinde.

The local distribution of this species depends on rocks, for it does not occur outside boulder-strewn or rocky-kopje country. It shows adaptability in that the Kilamatinde specimens were seen on the walls of a house.

The number of scale-rows at mid-body does not appear to be of much help in defining this variety.

2 Dodoma males	80, 89	gives	an	average of	84	scale-rows,
1 Izikisia	„ 80	„	„	„	80	„
7 Gwao's	„ 71, 72, 74, 74, 74, 77, 80	„	„	„	75	„
1 Pooma	„ 70	„	„	„	70	„
4 Mtali's	„ 70, 75, 76, 79	„	„	„	75	„
13 Mtali's females	70, 71, 72, 72, 73, 74, 74, 75, 76, 76, 76, 77, 79	„	„	„	74	„

The localities are arranged from south to north, and I think, though the series may be considered small, bear out my previous contention that as you proceed south from the type locality of *A. lionotus* (Lake Rudolph) you get an increase in scale-rows, I do not think this means that the scales are smaller but that the body girth is greater, in proportion to the greater lengths attained by the more southerly form.

The femoral pores of eight males examined range from 10 to 13 with an average of 11.

I therefore feel justified in proposing a varietal name for this strikingly handsome form according to the description given on page 142 of the P. Z. S. 1920, from a specimen in my collection. I now designate as types a male from Gwao's, 10. x. 21, and a female from Gwao's, 3. x. 22, which have been donated to the British Museum.

The coloration of an immature male from Dodoma (11. vii. 21) may be of interest as it is so different from the adult:—"Above slaty-grey intermixed with brownish-olive or dull-coppery colour; small irregular patterns in dark brown on head, neck, and fore-limbs; a semicircle of cream spots on parietal region with occipital scale as apex of the semicircle having one cream spot anteriorly in contact, and one on either side; coppery colour best developed on neck, where there are two slightly curving creamy stripes well separated from the faint nuchal crest. Whole of lower surfaces white, the throat only being mottled or streaked with greyish reticulations."

There were eight eggs (23×11 mm.) in the ovary of a Kidai female and apparently quite ready for laying (18. ii. 23). Young ones about two inches long were very numerous between Kidenge and Pwaga (ii. 23).

In the stomach of Gwao's specimens was a quantity of fruit, in another the leaves of "upilo." Other indeterminate vegetable matter in many others, also termites and ants of various species, including, I believe, a stink-ant (*Paltothyreus* sp.). At Izikisia I watched one of these lizards snapping up termites after a rain-storm, which was causing them to emerge in large numbers. The stomach of an Ikikuyu specimen was crammed with termites.

A very high percentage of these lizards are affected with a parasitic nematode worm (*Thelandros* sp., ♀ ♀ non det.).

I had great difficulty in hunting these active lizards on the rocks until I offered a small reward to the delightful small boys of the Wanyaturu tribe, who are experts with bows and arrows, which they all appear to carry. They began shooting them, which I had presently to stop for lack of preservative. They gave me to understand that they hunt and eat them in times of scarcity, and this is very possible, as these youngsters regularly ate the bodies of the rats as they were skinned.

AGAMA LIONOTUS var. MWANZÆ, var. n.

The Wasakuma call this Agama "kuli."

In Mwanza district forty-one specimens were collected of an entirely different Agama, but which has no specific characters by which I can distinguish it from the foregoing. They are abundant in Mwanza itself, but were not collected there, my series coming from Mwadira, Shanwa, and Sagayo. For this colour-form I propose the varietal name of *mwanzæ*, with Shanwa, Mwanza, as type locality. The ♂ and ♀ types collected on 20. x. 22 have been presented to the British Museum.

The longest neck-spines were less than half the diameter of the ear-opening, *i. e.* 2 mm. and 5 mm. Labials 10–11. Præ-anal pores of the males ranged from 10 to 13 and averaged 11, this being based on twenty-one males examined.

The number of scale-rows at mid-body according to locality and sex are:—

1 Sagayo male 87	....	gives an average of	87	scale-rows,
7 Mwadira males range from	71 to 90	„	79	„
15 Shanwa „ „ „	70 to 82	„	76	„
8 Sagayo females „ „	70 to 78	„	73	„
11 Shanwa „ „ „	70 to 85	„	77	„

which gives a range for the variety of 70 to 90 with an average of 78.

The coloration of the adult male.—"Snout to just beyond mid-body metallic purplish-pink; fore-limbs from elbows to finger-tips and whole of hind-limbs and tail a very rich metallic blue, brighter below than above. The females are much more like those of the Dodoma form, but are readily distinguishable by the vermiculations on the back."

The greatest body-length attained by males in this series was 130 mm. in two specimens, both of which had regenerated tails; of the perfect males the largest was 13⅛ inches (127 + 207). None of the females collected were very large.

Females collected at Shanwa on 19. x. 22 had eggs developing in the ovaries: (*a*) six measuring 20 × 10 mm., (*b*) eight eggs 17 × 10 mm., (*c*) eight enlarged but still round 6 × 6 mm.

I am almost inclined to say that this Agama is primarily a vegetable feeder, and only secondarily insectivorous. Many of the stomachs had nothing but vegetable matter in them, others a mixture of vegetable and insect food; of insects, ants appeared to be the favourite fare, but it must be remembered that soft-bodied insects such as diptera are so masticated that they are very difficult to find; a few beetle elytra were found and one bug. I watched (both with and without glasses) a pair of these lizards on several occasions come down from their rock and bite off the sprouting green grass at its base and also the leaves of a small shrub. The female always appeared bolder than the male, and would venture away from the rock in pursuit of insects.

A Hawk (*Melierax poliopterus* Cab.), shot between Mwadira and Shanwa on 19. x. 22, was found to have dined off one of these lizards, and a day or two later I saw a female Hawk of the same species feeding its young in the eyrie with a full-grown agama. Indeed, at Shanwa, unless the Kites eat these lizards which simply swarm, there appears to be very little other food for the large number of Kites which are ever circling about the rocks.

The Agamas are also heavily infested with the nematodes *Strongyluris brevicaudata* Müll., *Thelandros* sp., and *Strongyluris*, sp. nov.

AGAMA FLAVICAUDA Werner.

Wern. Zool. Anz. xx. 1897, p. 264.

During November 1920 at Eldoret, Kenya Colony, I saw what I am almost certain were agamas of this species on a heap of stones. They were quite numerous, but I failed to capture any.

AGAMA ATRICOLLIS Smith.

Blgr. Cat. Liz. i. 1885, p. 358.

Upongo in Luguo (Kavirondo).

Five males from Kilosa, Sanga, Kisumu, and Nairobi. This lizard is thoroughly arboreal, most of my specimens being captured on tree-trunks.

The largest male measured 12 inches (165 + 240); this must be something of a record for the species!

Preserved specimens give one a very poor idea of the colouring during life. The following is taken from a Nairobi specimen collected 14. viii. 20:—"Top of head coppery-green, sides of head bright verdigris-green, edges of lower jaw the same. Throat light cobalt-blue, a few white spots below ear-drum on base of jaws. A black blotch in front of each shoulder united by a dusky patch across neck. Vertebral line from head to base of tail occupied by a chrome stripe tending to green near the tail. Anterior surface of fore-arms cobalt-blue. Breast region dark blue and dusky copper colour; belly lighter, with vermiculations. Sides brownish, with black vermiculations and scattered yellow scales. Under surface of all limbs and upper and lower surface of tail brown."

A Kilosa specimen, the large one whose measurements have just been given, had "Head bright cobalt-blue or coppery-green, paler scales intermixed with the darker on the sides of face. Dark blue on median line between eyes to about the occipital scales. Throat bright blue in centre, remainder pale blue and olive marbled with darker. Body olive, but heavily marbled with black and speckled with blue. Tail pale olive at base, merging into blue about half its length. Lower surfaces of body, limbs, and tail pale sandy or slightly rufous."

This Agama consumes an enormous quantity of ants. I have also found what were apparently orthopterous eggs in its stomach.

I think that this Agama is the Mjombakáka of the Waswahili, concerning which they believe that it will intercede for men condemned at the day of judgment, when toads will come and spit water upon them to alleviate their pain (*Koch*). This is very interesting in view of the fact that N. African Agamas are detested by good Mahomedans, who see in their bobbing heads a caricature of the Moslem at prayer and think the lizard mocks them. In this action of the Agama the Wakavirondo see a likeness to the motions of a woman's head whilst grinding corn, and consequently, when they see an Agama bobbing its head, enquire if its mother is grinding to-day.

ZONURIDÆ.

ZONURUS TROPIDOSTERNUM Cope.

Blgr. Cat. Liz. ii. 1885, p. 254.

One Zonure was caught running over papers on the table in a tent at Msimba, Ilonga; another was found in the stomach of an immature female Bare-faced Hawk (*Polyborides typicus*) at Kipera, 5. viii. 22. Some two months later the former was caught and eaten by a baby lemur which shared the same cage. The Zonure fed readily on grasshoppers during its captivity.

VARANIDÆ.

VARANUS NILOTICUS Linn.

Blgr. Cat. Liz. ii. 1885, p. 317.

The Ukerewe name for this Monitor is Eikwambo, the Ugalla name is Mbulu, the Wasukuma call it Mbulu also.

Five specimens were collected at Ilonga, Kilosa, and Tindiga, but also seen at Mkata River, Sagayo, Karungu Bay in Tanganyika Territory, and Kisumu in Kenya Colony.

The largest female was $50\frac{1}{2}$ inches (519+761); monitors on Lake Victoria attain an enormous size; a pair habitually basked on a big rock south of Kisumu and were like small crocodiles.

One large female was killed by falling from a very high tree; no branch fell with it, and the natives say that it is by no means uncommon for them to fall asleep when basking on a branch and, forgetting their position, move and fall.

In the stomach of this specimen was a gecko (*H. mabouia*), three large limicolarian shells, grasshopper legs, and some cartilaginous lumps that looked like the pads of a cat's claws—if so, they had been picked up from some skin thrown away. Another Kilosa specimen nearly 4 feet long had in its stomach 22 elephant hawk-moth larvæ, 13 black coleopterous larvæ, and one cockchafer. Yet another contained crabs and a large quantity of mud. A young male had two crickets and crab remains in its stomach. None had visible parasitic worms.

Ticks (*Aponomma exornatum* Koch) were found about the vent and feet of one specimen. Another monitor had them on the fore-leg near armpit.

VARANUS OCELLATUS Rüpp.

Blgr. Cat. Liz. ii. 1885, p. 308.

Kenge is the general Kiswahili name for monitors as Mbulu is for the Wasukuma, who do not distinguish species. The Ugalla have a special name for the Eyed Monitor, which they call Enumusa.

A male 48 inches long (557+657) was found crawling in the road at Kilosa with bleeding mouth and fractured skull. It had almost certainly fallen from a tall and solitary tree a few feet away. Curiously enough a native had reported a "Kenge" being seen up this tree some months before.

A single female $53\frac{1}{2}$ inches (597+763) from Tindiga had no fewer than 35 eggs (60×40 mm.) in the oviducts, 13 of these being in the left and 22 in the right. There were parasitic worms (*Physaloptera paradoxa* v. Linst.) in the stomach, and ticks (*Aponomma exornatum* Koch) on the scales.

Amphisbænidæ.

Geocalamus modestus Gthr.

Blgr. Cat. Liz. ii. 1885, p. 453.

Two specimens which are, I believe, the only ones recorded since Günther described the species over forty years ago.

The type locality is Mpwapwa, and my collector obtained a male from Ikikuyu, some 80 miles south of Mpwapwa, in sandy soil. It measures $10\frac{3}{4}$ inches (240+34); 241 annuli on body; a mid-body annular ring consists of 36 segments and a caudal ring of 31. The first labial on the right side appears to be incompletely separated from the nasal. There are only three præ-anal pores, one being obviously missing. The colouring above is plumbeous, not brown, below pure white, somewhat transparent in life.

The other specimen is a young one, and was found in the stomach of a Banded Mungoose (*M. mungo colonus*) at Usshora, Mkalama Dist., 31.x.21. These records are extremely interesting, extending as they do its known range to the west and south.

Geocalamus acutus Sternf.

Sternf. Ergebn. Deutsch.-Zentr.-Afr. Exp. 1912, iv. 2, p. 209.

There is, in the British Museum, an Amphisbænid which I do not hesitate to refer to this species. Collected at Samburu (near Voi) Kenya Colony about 1897 by Betton. It has 209 annuli on body and 22 on tail. It measures 230 and 29 mm.

Lacertidæ.

Nucras emini Blgr.

Blgr. Ann. & Mag. Nat. Hist. (7) xix. 1907, p. 488.

The Wanyaturu know this lizard by the name of Kungulupe. It is comparatively common in the dusty, sandy fields of stubble which cover large areas in their district.

One which was captured alive at Mpanira had bolted down a hole, obviously its own to judge by the tracks leading to it. The hole was occupied in one portion by a giant cricket which had probably excavated the burrow.

The Shanwa female darted across the path and into a very small clump of grass surrounding a sprouting acacia. With the object of driving it out I set fire to the grass, which flared up and was burnt in about two minutes. The lizard made no attempt to escape and was picked up dead.

Forty-five specimens of a Nucras were collected at localities intermediate between the type locality of *N. kilosæ* (Kilosa, Morogoro Dist.) and *N. emini* (south shore of Lake Victoria), viz. Ikikuyu, Mpanira-kwa-Sagoi, Kidenge, Suna, Pooma, Zinzerigi, Mtali's, Shanwa, Nyambita, Tambali, and Izikisia, representing no fewer than four districts.

The largest male measured $7\frac{1}{8}$ inches (62+120), and female $9\frac{1}{2}$ (75+150).

Except in the matter of coloration and pattern and that the keeling is less noticeable on the dorsal scales, they agree with the description of *N. kilosæ* in all essentials. I had only time to examine critically 25 of this long series, however.

Ventral plates in 28 to 32 rows; average of 25 specimens 30.

Dorsal scales 38 to 46 across mid-body; average of 25 specimens 47·6.

Femoral pores 9 to 12, with an average for the 25 specimens of 11.

There are several individual variations. In one Pooma specimen the præ-frontals and frontal are rugose. The subocular is between 4th and 5th upper labials in all cases except three abnormalities, which are normal on one side. In two Pooma specimens it is between 3rd and 4th, and between 6th and 7th in one Shanwa specimen. In all 25 the normal number of 4 supraoculars were found. A Shanwa ♀ had 33 ventral scale-rows with 40 scales across mid-body.

Miss Procter, though very busy at the time, kindly examined the first 18 specimens which I sent home with a series of *N. kilosæ*, and made the following memo. on them:—"The large series which is before me points to intergrading between these two species. The scales in *emini forma typica* are granular but keel-less. In the types of *kilosæ* they are strongly keeled. In the present series the scales are tubercular (prominent), leading up to the *kilosæ* state. The markings also vary. There are two types—that of the typical *kilosæ*, and a speckled lighter brown variety. These points want going into thoroughly. Probably *kilosæ* must rank as a subsp." Unfortunately I have been unable to go over the whole series and critically compare them with the British Museum specimens, as I have had so much other work to attend to whilst on leave.

Coloration of a male from Gwao's was as follows:—"A white lateral line from middle of ear-opening above fore-arm to hind-limb; another commencing above ear-opening is broken up into short dashes, and ends just above juncture of hind-limb with trunk; a third from outer border of parietals vanishes on tail; this one is bordered on either side by black specks; a fourth (vertebral) line starting from occipital scale also vanishes on tail; this one is bordered on either side by black specks. In all, therefore, there are seven light lines and six rows of black spots. General colour is sandy above, darker, almost olive, on crown of head. Ventral and lower surfaces white.

A strikingly parti-coloured female from the same locality had the head and forepart of the body to mid-body olive colour; there are traces of only three of the light dorsal lines mentioned in the description of the male; of these the lateral two are very white, the interspace between them and above the other being black.

All markings vanish at mid-body, the posterior half being pinkish shading to sandy-buff on the tail. Four other specimens have the upper surface much speckled with black, approximately in ten longitudinal rows. Though showing much variation in colouring, these lizards are very different from *N. kilosæ* and readily separated at a glance.

A female (60+95) from Shanwa, 20. x. 22, had ovules rather large; another (67+r) from Ikikuyu, 10. ii. 23, held six ovules measuring 7×7 mm. The testes of a male killed on the same day were enlarged.

Stomach contents of eight specimens examined were:—(1) cockroaches and termites, (2) a brown shield-bug, (3) grasshopper and cricket, (4) spider, (5) cricket, many termites, and a spider, (6), (7), (8) full of termites.

NUCRAS KILOSÆ Loveridge.

Love. P. Z. S. 1922, p. 313.

Three specimens from Gwao's and Mtali's should be referred to *kilosæ* on colour grounds and possibly on the basis of keeled dorsals. As pointed out under *N. emini*, there appears to be intergrading in specimens collected mid-way between the type localities of *N. emini* and *N. kilosæ*, and the latter is probably only a subspecies of *N. emini*.

Since describing this lizard I have obtained eighteen further specimens from the type locality. Twelve were males, four females, and two very young. The disproportion in the sexes is probably to be attributed to a greater agility on the part of the females in eluding capture.

The largest perfect male measured $8\frac{3}{8}$ inches (65+147), whilst another exceeded previous maximum measurements by being 67 mm. from snout to vent; the tail was reproduced in this specimen. As the tail was missing in the type female, it may be well to record the measurements of the three perfect specimens in the present collection. (*a*) 50+117, (*b*) 50+113, (*c*) 43+88.

A careful study of the scale characters of these specimens enlarges our knowledge in several particulars, viz.:—

"Ventral plates in 27 to 31 transverse series" should read 25 to 31. The average of these fifteen is 27.

"Dorsal scales 42 to 56 across mid-body" should read 40 to 56.

"Femoral pores 11 to 13" should now be 10 to 13, the average of the fifteen specimens being 11·6.

In one the frontal and fronto-nasal were broadly in contact.

Four of these specimens had grasshopper remains in their stomachs.

One specimen had a number of parasitic nematodes in the stomach which were identified by Dr. Baylis as *Physaloptera abbreviata* Rud.

LACERTA JACKSONI Blgr.

Blgr. P. Z. S. 1899, p. 26, pl. x.

I take this opportunity of correcting an error on p. 147 of my previous paper, when I hastily referred specimens of this lizard to *Lacerta vauereselli* Tornier.

ALGIROIDES ALLENI Barbour.

Barb. Proc. New Eng. Zool. Club, iv. 1914, p. 97.

Hearing that Dr. J. Arthur was making an ascent of Mt. Kenya this spring, I asked him to look out for tree-lizards, and he was successful in obtaining three specimens of *A. alleni* on Feb. 4th and 5th at 9970 feet.

LATASTIA JOHNSTONI Blgr.

Blgr. Ann. & Mag. Nat. Hist. (7) xix. 1907, p. 392.

Seven specimens from Kimamba, Tindiga, Tabora, Nyambita, and Bukoba. Was also seen at Mkata Stn., Mkata River, and all the way to Wami River along the foot-path. It shows a great liking for sandy, sunny paths.

The coloration of breeding males and females is somewhat different from that already described for this lizard in "off plumage," and was as follows:—

Male from Tindiga, 31. viii. 22.—"General colour reddish, shading into nut-brown and pale fawn posteriorly and on tail. The 'blue spots on the sides' are a very pale blue in one specimen, and almost white in another. Upper and lower labials, mental, lower sides of neck and belly (more particularly along the edges) heavily blotched or patched with brilliant lemon-yellow."

Female from Kimamba on 5. viii. 21.—"A yellow median dorsal line with black edges commences at occipital and disappears on base of tail. A yellow line from the outer edge of the parietal also vanishes on the tail. Another yellow line commencing on the labials passes over fore and hind limbs and disappears on tail. A series of yellow dashes, each surrounded by black, lie between these two last-mentioned lines, the first dash commencing behind eye, and the last ending above the hind limbs. Limbs slightly spotted with black and yellow, but no such spots on the dorsal region which is plain brown. Throat and underparts of body pure white."

I thought I had some very interesting variations to report on, but Mr. Boulenger has described all such in his exhaustive treatment of this species in the Monograph *, and leaves little to be added.

The number of femoral pores cited in the Monograph for this species is 13 to 16, a Nyambita specimen has 12, while the

* Boulenger, 'Monograph of the Lacertidæ,' vol. ii. 1921, p. 16.

Kimamba female already mentioned has only 11. In two of my specimens there are only four labials anterior to the subocular, which is mentioned as a matter of rare occurrence in the Monograph.

Pairing takes place in July presumably, as large ovules are to be found in the ovaries early in August.

Two specimens were found in the stomach of a Heron (*Ardea melanocephala*) at Sagayo, but as I did not see this lizard during a fortnight's stay at Sagayo, I have not recorded it from this locality.

LATASTIA LONGICAUDATA Reuss.

Blgr. Cat. Liz. iii. 1887, p. 55.

Thirteen Long-tailed Lizards were taken at Pwaga, Itende, Igulwe, Dodoma, Mtali's, and also many were seen near Kidete. One was also collected at Port Sudan on the voyage out.

A female from Dodoma exceeds my previous records for body-size, being $11\frac{3}{4}$ inches (100 + 196 mm.) over all. The series show a good deal of variation; the occipital is very small and often broken up in these specimens.

Parasitic worms were found in the intestines of an Igulwe specimen.

GASTROPHOLIS VITTATA Fisch.

Blgr. Cat. Liz. iii. 1887, p. 7.

A single specimen taken alive at Kilosa on 15. i. 23. I found it crossing the floor in a room in the Otto House; as ceiling, walls, and floor were cement and the windows insect-proof, it was rather a mystery how it gained admittance. There were no rains on at the time. In captivity it refused all food for a week, but drank a good deal of water; it then took two wasp grubs. A month later it was allowed to escape by the boy in charge whilst I was away. The species is very rare.

EREMIAS SPEKII Gthr.

Blgr. Cat. Liz. iii. 1887, p. 84.

Native names are Kungulupe in Kinyaturu and Kishagasi in Kinyaramba.

One hundred and fifty-nine from Itende, Pwaga, Igulwe, Gwao's, Suna, Pooma, Mdjengo's, Mtali's, Tambali, Ulugu, and possibly Dodoma. It was common in a sort of "sage-bush" scrub at Kidete; seen at Kidai.

This widely-distributed lizard is nowhere scarce where it occurs, but some idea of its astonishing abundance at Mtali's may be gathered from the fact that on my arrival at this place at 11 a.m.

I gave out that a small reward would be paid for all lizards brought in, and by 3 p.m. my boy had paid out for 150. On learning this I stopped the offer, and in future was more careful in asking for specimens, as I had no wish to destroy such numbers of a useful little creature.

The largest male measured $6\frac{5}{8}$ inches (52+115), and female $6\frac{3}{8}$ (45+115).

A careful examination of this long series for Stejneger's *Eremias sextæniata* only revealed four aberrant specimens. Two of these had the subocular separated from the buccal margin by the 5th and 6th labials, whilst two others had the subocular separated on the one side by a 5th, or 5th and 6th labial, whilst the other side was perfectly normal. The only two specimens taken at Gwao's—a male and female—were alike in having but 4 labials anterior to the subocular on the right side and 5 on the left. *E. sextæniata* was probably founded on two abnormal individuals which, in addition to the subocular being separated from the mouth, had the central light dorsal line completely divided, making six dorsal lines in all. The abnormal specimens referred to above had only the anterior portion of the central line divided, as is typical in *E. spekii*.

A female with enlarged ovules measuring 10×6 mm. was taken at Dodoma on 20. xi. 21. Many new-born young were seen on the road from Mpanira to Pwaga (13–15. ii. 23).

Specimens from Suna and Tambali had their stomachs full of termites.

Two were taken from the stomach of a Hawk (*Melierax metabates*) at Ulugu, 11. xi. 21, and the pregnant female referred to above was in the stomach of an Augur Buzzard (*Buteo augur*) at Dodoma, 20. xi. 21.

GERRHOSAURIDÆ.

GERRHOSAURUS MAJOR A. Dum.

Blgr. Cat. Liz. iii. 1887, p. 121.

Seen at Zanzibar, Mt. Kirui, Mkindo River, Kilosa, Ulugu, and Luguo. Most of these specimens could have been captured if desired.

At Mt. Kirui they occur at a great altitude, and as elsewhere, are associated with rocks, under which they retreat; one caught at Kipera, however, had its refuge in a hollow tree-trunk, where it remained whilst a fierce bush-fire burnt up the surrounding herbage and blazed for fully five minutes against its retreat, which was full of smoke. It emerged none the worse when the fire had passed.

My native collector, who has caught several of these lizards, states that he saw one dead at Luguo which had a bright red belly and was not so coloured from putrefaction.

Gerrhosaurus nigrolineatus Hallow.

Blgr. Cat. Liz. iii. 1887, p. 122.

Three specimens available for the present paper, though others were taken alive or seen at Frere Town, Dar es Salaam, Mbala, Kilosa, Kidai, and Ikikuyu. This species is not nearly so abundant at Kilosa as at Morogoro, for which it is difficult to assign a reason, as the type of country is similar.

In my last notes I assigned these lizards to *G. flavigularis flavigularis*, following Schmidt's ruling of its being the eastern geographical race, while he called the western *G. f. nigrolineatus*, though I pointed out that many of my specimens conformed with *G. nigrolineatus* rather than *G. flavigularis*. Miss Procter demurs to my referring the three specimens under consideration to *G. flavigularis*, and points out a striking difference not mentioned by Schmidt. In *G. flavigularis* the laterals are smooth and the dorsals only feebly keeled, but in *G. nigrolineatus* the laterals are keeled and the dorsals so strongly keeled as to form almost continuous ridges along the back.

A young male was taken on 5. vii. 21 which measured $10\frac{1}{2}$ inches (90+174). Another male, total length $20\frac{1}{4}$ inches, had an exceptionally long tail $14\frac{1}{2}$ inches (145+365). The tail is therefore two and a half times the length of the head and body as against two times as given in the Catalogue.

The points in which this specimen differs from "*flavigularis*" of the Catalogue are:—Head-shields faintly keeled and pitted. Frontonasals widely separated from frontal by broad suture of the præ-frontals. Lateral scales quite distinctly keeled. Femoral pores 16–15. I might add that there are 22 longitudinal and 58 transverse rows of dorsals. Ventrals in 8 longitudinal rows.

The coloration of the living lizard is very handsome. General colour above nut-brown. A yellow vertebral line, bordered by black lines, commences two scales behind the parietals and continues three-quarters of the way along the tail. A series of black spots along the back between the vertebral and dorsal lines. Sides scarlet, alternate scales being brown and yellow so as to form vertical stripes. Under surface pure white.

For several days in succession I had seen this specimen disappear into a burrow at the base of a bush; it had only come to occupy the burrow quite recently, as I passed the spot four times daily. Apparently it had cleaned out the burrow before occupying it, as my attention was first attracted by the heap, and little slide, of fresh earth at the entrance. Thinking that it might be laying in the hole, I got my native collector to make a snare at the entrance of the burrow which twice caught the occupant, but it wriggled free. The laborious process of digging it out was therefore resorted to, and the burrow found to be over a yard in length with two smaller blind alleys opening off it.

Grasshoppers and many termites in stomach of an Ikikuyu male.

Scincidæ.

Mabuia comorensis Peters.

Blgr. Cat. Liz. iii. 1887, p. 163.

A single male from Frere Town, Kenya Colony, 2. viii. 20. Whilst collecting butterflies under the mango-trees I heard a rustle and rush among the dead leaves some ten feet from the trunk of a mango. Running to the tree I was just in time to put my hand on a handsomely-coloured skink as it ran up the trunk.

It is with some misgivings I refer it to *comorensis*, as the head seems broader and the scalation slightly different from examples in the British Museum collection.

Its total length was $8\frac{1}{5}$ inches (79+132 mm.).

The 6th upper labial was longest and deepest on the right side of head, and the 5th on the left.

It had 34 scales round mid-body, and agreed in every respect save coloration with the description given in the Catalogue.

Above greenish-olive; sides of head, nape, and back sprinkled with green and black spots. Rims of eyelid bright yellow. A creamy stripe, black-edged above, below eye. Borders of ear-opening yellow. An orange side-stripe commencing at ear vanishes on base of tail; sides below this pale bluish-grey, belly gamboge-yellow. Throat bluish, a few black marblings on sides of throat and base of tail.

Mabuia maculilabris Gray.

Blgr. Cat. Liz. iii. 1887, p. 164.

Four females from Frere Town, Mkindo River, Kipera, and Jumbe Sunguru's, near Kilosa; two were seen at Kidete.

In some specimens the toes of the adpressed hind-limb only just reach the fingers, instead of reaching to, or nearly as far as, the elbow.

The Kipera female measured $9\frac{7}{8}$ inches (82+168), and had seven white eggs in her ovary measuring 14×9 mm. In her stomach was a small frog!

Mabuia planifrons Peters.

Blgr. Cat. Liz. iii. 1887, p. 167.

Mabuia diesneri Sternfeld, S.B. Ges. naturf. Berlin, p. 248, 1911.

Four specimens from Ndogwe, Ulugu, Izikisia, and Tabora.

The Ndogwe individual was found in open Mbugwe country with scattered thorn-bush. It bolted into a rat-hole at the root of one of these, from which it was dug out. The Ulugu and Izikisia specimens were seen on tree-trunks, and sought shelter in fissures in the bark or holes in the bole. The Tabora specimen was found freshly killed in a roadside shelter. Yet another was seen at Luguo

The type locality of *M. planifrons* is Taita, Kenya Colony, and that of *M. diesneri* is Kibwezi, Kenya Colony, not far distant from Taita. *M. diesneri* has also been recorded from Tabora; my Tabora skink agrees with the description of *M. diesneri* with three exceptions: (1) the first supraocular is not in contact with the large frontal; (2) the light stripe bordering upper edge of black lateral band indistinct; (3) no light patches on back and sides. The other three specimens whilst agreeing in the main with *M. planifrons* have some of the characters of *M. diesneri*, which was founded on a single small individual. The colouring of the two species as given in the published descriptions appears identical, whilst the differences in scalation are not greater than one meets with in variable skinks such as *M. striata* and *M. varia*. I state the differences as given in the descriptions in tabular form for convenience.

M. planifrons.	*M. diesneri*.
Scales in 28-29 rows.	Scales in 32 rows.
Scales with 3-5 keels.	Scales with 3 keels.
Frontal in contact with 2nd and 3rd supraoculars.	Frontal in contact with 1st, 2nd, and 3rd supraoculars.
Ear-opening with 2-3 projecting lobules anteriorly.	Ear-opening with 4 projecting lobules anteriorly.
Adpressed hind-limb does not reach the elbow.	Adpressed hind-limb reaches as far as the elbow.
Olive-brown above; two rows of irregular black spots along the back.	Brown above, with long rows of little black spots.
Light ocelli as in *Chalcides ocellatus*.	Many feebly-marked light patches on back and sides.
A black lateral band beginning from the eye; on each side of the back a broad lighter longitudinal band.	A deep black band runs along sides of body, especially dark on temples, bordered above by light stripe.
	Underparts yellowish-white, sprinkled brown on sides of throat. Borders of ear-opening, labials, and rostral orange-yellow.

I therefore propose uniting the two species by enlarging the description of *M. planifrons* to read:—

Scales in 28 *to* 32 *rows. Frontal in contact with* 2*nd and* 3*rd or* 1*st*, 2*nd*, *and* 3*rd supraoculars. Ear-opening with* 2 *to* 4 *projecting lobules anteriorly. The adpressed hind-limb may or may not reach as far as the elbow.*

Largest undamaged ♂ measured $7\frac{1}{8}$ inches (65+127), largest ♀ 12 inches (108+195). The latter's stomach contained a field cockroach and what appeared to be the remains of a grasshopper.

MABUIA VARIA Peters.

Blgr. Cat. Liz. iii. 1887, p. 202.

Mabuia isselii (Peters), Blgr. Cat. Liz. iii. 1887, p. 201.

Mabuia hildebrandtii (Peters), Blgr. Cat. Liz. iii. 1887, p. 207.

Forty-three specimens from Mt. Kenya, Mbala, Mtali's, and Shanwa. Also seen at Kidai, Kidete, Kidenge, Itende, Ndogwe, and Sagayo. It is almost invariably found in association with rocks, though occasionally seen on, or beneath, logs and stones.

This large series was collected in the hope of throwing light on the relationships of *varia*, *isselii*, and *hildebrandtii*. I may be considered rash in adding the latter to the already long list of synonyms of *M. varia*. Tornier has indeed made *isselii* a synonym of *varia* in recording a specimen from this region; practically *isselii*'s only point of difference from *varia* is in its possession of a single frontoparietal caused by the fusion of the frontoparietals. There is only one such specimen in the series—an adult male from Mbala, where it was taken near typical *varia*, and what may be considered *hildebrandtii*. It has 34 scale-rows. The reason for *isselii* only having 30 is due to the fact that so few specimens have been collected that the range is not so well known as in *varia* and *hildebrandtii*, in both of which it is 30–34.

Perhaps the feature distinguishing *hildebrandtii* from *varia* more than any other is that "the hind-limb reaches the axilla or the shoulder of the fore-limb."

In one Mtali ♀ the hind-limb extends considerably beyond the axilla, in a ♂ from Gwao's and a ♀ from Mbala the axilla is just reached, in a ♂ from Mbala and many others it just falls short; and the variability of this feature, as shown by the series now before me, demonstrates there is no taxonomic value to be placed on this character. The amount of contact between the anterior loreal and first labial also varies greatly.

The Mbala specimens have 34 scale-rows at mid-body.

If *isselii* and *hildebrandtii* are to be united with *varia*, the description of *varia* would have to be enlarged in some respects, and would then read:—

Anterior loreal usually (rarely not) in contact with the 1st labial. Frontonasal broader or as broad as long. Frontonasal usually (sometimes not) in contact with frontal. Frontal a little shorter or as long as the frontoparietals and interparietal together, in contact with 2nd and 3rd (rarely 1st) supraoculars. Frontoparietals distinct or occasionally fused. Parietals usually meeting behind the interparietal, though sometimes widely separated. Subocular feebly or strongly narrowed inferiorly. Ear-opening with 2–5 lobules anteriorly, either short-pointed or long lanceolate. 30–36 *scales round mid-body. Hind-limb reaching to the wrist or shoulder (or beyond) of the adpressed fore-limb. Subdigital lamellæ sharply tricarinate, occasionally unicarinate.*

For the convenience of anyone interested in the alleged distinctive characters of the three forms, I have isolated those characters where all three are not in agreement, and present them in tabular form:—

M. varia.	*M. varia* var. *isselii.*	*M. hildebrandtii.*
Anterior loreal usually in contact with 1st labial.	Anterior loreal *not* or slightly in contact with 1st labial.	Anterior loreal largely in contact with 1st labial.
Frontonasal broader than long.	Frontonasal broader than long.	Frontonasal as broad as long.
,, usually in contact with frontal.	,, sometimes in contact with frontal.	,, usually in contact with frontal.
Frontal a little shorter than the frontoparietals and interparietal together.	Frontal a little shorter than the frontoparietals and interparietal together.	Frontal as long as the frontoparietals and interparietal together.
Frontal in contact with 2nd and 3rd supraoculars.	Frontal in contact with 2nd and 3rd supraoculars.	Frontal in contact with 2nd and 3rd (rarely 1st also) supraocular.
Frontoparietals distinct.	Frontoparietals fused to a single shield.	Frontoparietals distinct.
Parietals usually meeting behind the interparietal.	Parietals forming a suture behind the interparietals.	Parietals forming a short suture behind the interparietal, or entirely separated.
Subocular feebly but distinctly narrowed inferiorly.	Subocular feebly but distinctly narrowed inferiorly.	Subocular much narrowed inferiorly.
Ear-opening with 3 to 5 short-pointed lobules anteriorly.	Ear-opening with 2–3 short pointed lobules anteriorly.	Ear-opening with 3–4 long lanceolate lobules anteriorly.
30–34 scales round mid-body.	30 scales round mid-body.	30–34 scales round mid-body.
The hind-limb reaches the wrist or the elbow of the adpressed fore-limb	The hind-limb reaches the wrist or the elbow of the adpressed fore-limb.	The hind-limb reaches the axilla or the shoulder of the fore-limb.
Subdigital lamellæ sharply tricarinate.	Subdigital lamellæ sharply tricarinate.	Subdigital lamellæ sharply unicarinate.

Two females from Mtali's had each three well-advanced embryos on 9.x.22, and two others from Shanwa, taken on 20.x.22, had in one case three young very near birth, and in the other, three, in an early stage. It is curious that the number of young produced should be so much less than those recorded in my last paper. There were four embryos in a very early stage in an Mbala skink on 27. ii. 23.

Sixteen stomachs were examined, and in every case were found to contain termites, and in only one was any other food present so far as I could see, and that appeared to be the limb of a spider.

Minute nematodes in the stomach have been identified as *Physaloptera* sp. indet. as ♀ ♀ only.

MABUIA OBSTI Wern.

Wern. Mitt. Nat. Mus. Hamb. xxx. 1913, p. 43.

Two specimens from Kisumu, Kenya Colony. About a mile south of Port Florence, along the lake shore, these skinks are quite common, but apparently localized and confined to the rocks near the shore. Though structurally so similar to *M. striata*, they are strikingly different in coloration, being by far the handsomest East African skink I have yet met with. Unfortunately I made no notes on the exact colour at the time, and nothing is left of it in the preserved specimens. Speaking from memory however, only the anterior portion of the body in the adults was suffused with bright orange; the five longitudinal bands are bright blue both in the adult and in the young.

In one specimen the parietals are in contact behind the interparietal, in the other this is not the case. The fronto-parietals are not smaller than the interparietal as in *M. striata*. There are five large sharply-pointed, and one rounded lobule, anterior to the ear-opening. 36 scales round mid-body.

It may be worthy of note that several *M. striata* were taken at the same spot, but on tree-trunks, whilst *M. obsti* is obviously a rock-skink and is the most difficult to catch of any lizard. I spent a whole day trying to get some, and finally got these two specimens from a local native.

M. obsti was described from Kwa Mtoro, which lies between Dodoma and Kondoa Irangi in Tanganyika Territory, so that this record extends its known range considerably. I also saw it on rocks a mile west of Igulwe Stn. One was seen at Kidai, five at Pwaga, and two at Itende, but they successfully evaded strenuous attempts at capture.

MABUIA STRIATA Peters.

Blgr. Cat. Liz. iii. 1887, p. 204.

This familiar species is known to the Wanyaturu as Mwin-yansio, to the Wanyiramba as Tuni, and the Swahili as Mjusi salama.

Sixteen specimens from Dar es Salaam, Mkata Stn., Ilonga, Kimamba Stn., Kilosa, Suna, Gwao's, Mtali's, Mkalama, Usshora, and Tabora in Tanganyika Territory, where it was also seen at Uliya and Mbala. It was collected at Frere Town, Nairobi, Kisumu, and Karungu Bay in Kenya Colony.

The largest male measured $9\frac{3}{4}$ inches (108+136) and female $9\frac{7}{8}$ inches (109+140), from Dar es Salaam and Kilosa respectively. Two specimens from Karungu Bay and Kisumu had 37 mid-body scales, and many of these were quinquecarinate

Coloration of a female taken at Nairobi on 12.viii.20.—Rich nut-brown on upper parts turning to copper on tail, scales frequently iridescent. Head-shields edged with black. Light straw-coloured stripe commences above the eye, passes along the back in the dorso-lateral region, and disappears on the base of the tail. Upper labials and subocular pale straw-colour. Sides thickly besprinkled with similarly-colored light spots intermixed with black. Throat marbled with brown. Under parts white.

A female taken at Kisumu, 18.xi.22, only measured 100+90, yet had ten young *in utero* very near the birth. I should think this is the maximum for this species. A female at Kilosa gave birth to young on 22. ii. 23.

A Lesser Black Stink-Ant (*Paltothyreus tarsatus*) came running home with a crumb as large as itself, when a half-grown skink ran to meet it, seized the crumb, and gave it a terrier-like shake; the ant let go and retreated and the lizard dropped the crumb; the ant hurried back, seized it, and made a dash for its hole, the lizard giving chase but failing to catch it. Another skink was seen to seize a large hawk-moth and dart with it into a crevice in the wall. Examination of five stomachs gave the following results: (i.) ants; (ii.) termites; (iii.) cockroach and two large wolf (Lycosid) spiders; (iv.) beetle and three bugs (*Lygæus* sp.); (v.) beetle elytra and millipede rings of 4 mm. diameter. The fæces of another held the remains of a green bottlefly and a moth.

I have already drawn attention to the adaptability of this dominant species to all manner of habitats; its activity is also remarkable, as the following note made at Kilosa, 8.vi.21, will show:—"A rustle in the roof-gutter and a plop in a bush *four feet* from the gutter, and I was just in time to see a striped skink recover its balance and run quickly down the stalks and stem of a bush till it reached the ground, which it crossed with a rush to the stump of a rubber-tree, up which it darted as if a first-class arboreal species."

A Karungu Bay specimen had a large grey cattle tick (*? Rhipicephalus sinus* Koch) attached to, and completely blocking up, the ear-opening. Red acarine parasites were also abundant about anus, groin, axilla, and ear.

MABUIA IRREGULARIS Lönnb.

Lönnb. Arkiv för Zool. Band 14, No. 12, 1922.

Lönnberg has recently described a skink from Soy, Kenya Colony, as *Mabuia* (*striata* ? var.) *irregularis* n. ?, which is so very similar to three of my specimens that I do not hesitate in referring them to it, though the two immature ones are so dried up that they are of little use. These three skinks were collected for me on Mt. Kenya at an altitude between 10,000–11,600 feet by Dr. J. Arthur. I think the species is quite distinct from *M. striata*. The only differences between Lönnberg's description and my adult skink are (1) parietals *are* in contact behind interparietal, (2) a *single* pair of enlarged nuchals.

The largest agrees with *M. irregularis* in differing from typical *M. striata* in the following points, though *M. striata* being such a variable species, most of, if not all, these variations have been recorded from time to time:—

(i.) Anterior loreal *not* in contact with the first labial.
(ii.) *Two* pairs of supranasals.
(iii.) Frontonasal (in its divided state) *longer* than broad.
(iv.) Frontal shorter than the frontoparietal and interparietal together.
(v.) *Four* supraciliaries, second largest.
(vi.) The supraocular is *very well* separated from lip.

Length of adult 6 inches (69+83).

LYGOSOMA SUNDEVALLI Smith.

Blgr. Cat. Liz. iii. 1887, p. 307.

Ten specimens from Dar es Salaam, Mkata River, Kilosa, and Mwanza in Tanganyika Territory; Nairobi, Kisumu, and Karungu Bay in Kenya Colony.

The Mkata specimen was taken deep down in a termite heap. At Kilosa quite a number were taken in snap-back rat-traps; presumably insects went to the bread or cheese bait, and the skinks followed for the insects. At Karungu Bay and Kisumu these lizards were living beneath the boulders on the lake shore.

A female $9\frac{1}{8}$ inches (130+102) surpassed all my previous records and was the one taken from the termite heap.

A Nairobi male is much mottled on the under surface, like the Morogoro specimens referred to in my last collection; it is in striking contrast to all the other specimens collected this time, which are pure white beneath.

Four developing ovules (11 × 10 mm.) were taken from a skink at Kilosa on 1. ii. 21 and four from the Mkata specimen on 30. viii. 21. A very young skink (35+25) was caught at Karungu Bay on 16. xi. 22.

LYGOSOMA FERRANDI Blgr.

Blgr. Ann. del Mus. Civ. (2) xviii. 1898, p. 718.

Kilambamukoot is the Kinyaturu name and Kimilikuta the Kinyiramba.

Ten specimens collected from Mbala, Ikikuyu, Mpanira-kwa-Sagoi, Lukole, Kidenge, Itende, Kidete, Gwao's, and Pooma, and the remains of what I am confident was a Ferrand's Skink was found in the stomach of a Serval (*F. serval hindei*) at Sagayo. Most of my specimens were taken beneath logs.

The largest female measured $7\frac{1}{8}$ inches (95+85).

Mbala specimens were coloured unusually; an adult freshly killed was nut-brown above, each head-scale with a black mark, and each dorsal scale likewise, those on three central rows tending to form dorsal lines, which is achieved on 3rd row of scales from vertebral and forms the top of a dark lateral band. Lips whitish or yellowish, each upper and some of the lower labials bearing a blotch. Under surface of body lemon-yellow, tail pure white, regenerated portion plumbeous; sides of lower surface much speckled.

The young specimens are strikingly similar to *A. wahlbergi* in colouring except for the spotting on the head and the pinkish tails. Examination with a lens, however, shows the markings to be similar to that of the adult in reality.

Termites were found in the stomachs examined.

One skink was recovered from the stomach of a sand-snake (*P. biseriatus*) at Ikikuyu.

ABLEPHARUS WAHLBERGII Smith.

Blgr. Cat. Liz. iii. 1887, p. 350.

Twenty-five specimens from Dar es Salaam, Mkindo, Mbweni, Kilosa, Mbala, and Mpanira-kwa-Sagoi. At the latter place the species is very common amongst the sweepings and vegetable refuse bordering bush-paths. It is not uncommon beneath fallen tree-trunks, and one specimen was taken at the entrance of an "earth," down which it was fleeing.

A female measuring $4\frac{5}{8}$ inches (48+68). A male with enlarged testes was in breeding colours, undersides of limbs, tail, and along both sides of the body being rich salmon-pink (Dar es Salaam, 4. xii. 22).

The large female referred to above had six developing eggs in ovary measuring 6×3 mm.

MELANOSEPS ATER var. LONGICAUDA Tornier.

Torn. Zool. Jahrb. Syst. xiii. 1900, p. 602.

A single specimen at Mkata Station, where I found it beneath the ground-sheet of my tent when striking camp. The tent was pitched in a clearing in the bush, 24. viii. 21.

In referring to *Melanoseps ater* in the Catalogue, I see it stated "3rd upper labial entering orbit," whilst plate xxxvii. fig. 1 *b* in the same work does not clearly show this. My specimen differs from Tornier's description in the following points:—

18 scales round mid-body against 19 in Tornier's. 130 scales

from chin to anal shield against Tornier's 118–120. Mine measured 82+30 and his 71+41.

Coloration is uniform plumbeous above and below, whilst Tornier's description reads "Black-brown scales, little light borders," and his second specimen "Ventral and back scales black with white borders, back pale olive, two long rows of black spots close together near middle line" (rough translation).

The Mkata specimen is a female with two eggs measuring 9×4 mm.

Tornier's types are from Kerogwe and Masai-land, roughly from 100 to 200 miles farther north. I do not know of any other record of this interesting worm-like skink.

Acontias meleagris Gray.

Blgr. Cat. Liz. iii. 1887, p. 427.

As no Acontias has been recorded from East Africa farther north than Mozambique, I take this opportunity of drawing attention to a series of this limbless South African skink which were collected at Voi, Kenya Colony, by Capt. A. B. Percival, and which are now in the Museum of the Kenya and Uganda Natural History Society.

They differ considerably in the matter of colouring, being slaty-black above and pure white beneath in the half-grown; plumbeous above and slightly dusky beneath in the young. Not agreeing with the colour description given in the Catalogue.

Two specimens brought home for comparison measure 210+24 and 146+19 mm. respectively.

Chamæleontidæ.

Chamæleon senegalensis Daud.

Blgr. Cat. Liz. iii. 1887, p. 447.

A single female from Kabare, Bukoba, 26. xii. 22, measures 6¼ inches (92+66).

Chamæleon parvilobus Blgr.

Blgr. Cat. Liz. iii. 1887, p. 449.

Two males and a young one from Kilosa, Gwao's, and Sagayo. The last two found on bushes in the vicinity of rocky granite kopjes.

The larger male measured 7 inches (95+80), the smaller 83+80; the distance between the end of the casque and commissure of mouth is 20 mm. and length of mouth 18 mm. These examples were a rich dark green in life. Stomach contents—a grasshopper.

What appeared to be one of this species was found in the stomach of a mungoose (*H. g. lademanni*) shot at Mbulu's near Gwao's. The Kilosa Chameleon was killed by a young lemur (*G. pangánensis*) confined in the same large cage.

Chamæleon dilepsis dilepsis Leach.

Bigr. Cat. Liz. iii. 1887, p. 450.

Twenty-six specimens from Kilosa, Ikikuyu, Mt. Hundungula, Itende, Pwaga, Mbala, Mtali's, and Tabora.

The largest female measured 14 inches (184+172).

Mating takes place in the January and February (22. ii. 23) rains. The following note, taken direct from my diary, is of the pairing of a female whose hind-limbs and part of tail appeared partially paralysed, therefore what occurred may be somewhat abnormal.

Kilosa, 19. i. 21. There were some four chameleons in my vivarium, when a native brought me a large female (160+182), which was introduced into the case at 7.30 a.m.

7.45 a.m. I noticed she was on a branch facing a male; he was raising his occipital flaps from time to time; both had their throats vertically dilated. She leaned forward and bit him gently about the neck and head. Pairing I imagine took place shortly after.

8.15 a.m. As I was passing the case I noticed she was lying almost on her back except the posterior part which was horizontal. The male chameleon had his head entirely underneath her or buried in the grass.

Her right fore-leg grasped his right hind-leg.

His right hind-leg grasped her body.

His left hind-leg gripped round her tail, which he kept working to and fro, not moving himself.

His right fore-leg grasped her side.

His left fore-leg was in the grass.

8.21 a.m. She moved now and then, but except for the movement of his leg, he was motionless.

8.25 a.m. While continuing to grasp his hind-leg she bites feebly at him, turns slightly and grasps his back on the vertebral line in the lumbar region with her left fore-leg.

8.27 a.m. Quiescent. Colours strikingly different. The male a very pale grey-green with broad whitish vertical bands on sides. The female bright green. One of her hind-legs, which I suppose is partially paralysed, is doubled back in a most uncomfortable-looking position.

8.32 a.m. Anterior part of female distinctly on her back; right fore-leg of female grasping dorsal ridge of male now in the middle of his back. The male making movements.

8.37 a.m. Lines like leaf-veins appear on sides of male, who is inflated and taking deep breaths.

8.40 a.m. Commenced to disengage.

8.41 a.m. Separated, followed by the female excreting.

At this point I had to leave for the office, but was told that shortly after I had left the female commenced to follow the male about. On my return at 2.10 p.m. courting was in progress, both clinging to the gauze of the cage. The female gently biting the male on cheek, the male responded by raising his occipital flaps, inflating throat enormously, showing skin between scales. She then followed suit.

Kilosa, 29. i. 21. During the past ten days the female has been following the male about and sometimes *vice versâ*. Pairing has doubtless taken place, though I have not witnessed it until to-day, when the female was again lying on her back in the grass.

Kilosa, 1. ii. 21. The female was apparently dying, and so I gave chloroform. Subsequent post-mortem showed that the stomach contained plenty of fresh insect remains, but the intestines were choked with a very hard lump of matter, which on being broken up was found to be mainly composed of chitinous parts of insects.

Kilosa, 22. v. 21. One of my chameleons on a branch in the window dropped an egg on the floor between 2 and 2.20 p.m. This egg measured 12 × 9 mm. and, being soft, did not break.

Kilosa, 25. v. 21. The chameleon mentioned in my last note died egg-bound, there being plenty of fresh food in stomach. There were 46 eggs in the ovary measuring 14 × 9 mm.

Kilosa, iv.–6. v. 22. No less than three captive chameleons died when full of eggs, the highest number being 64. Why they refuse to lay in captivity when provided with a bush and soil I do not know.

I found a young chameleon (45 + 44) on a bush at Tindiga, 14. ii. 21.

Two Ikikuyu males were found to have been feeding on termites. A chameleon was found hanging by one hind-foot from a branch as if dead. It had disgorged three grasshoppers, one of which was still kicking feebly, together with a lot of blood and mucus. It would appear that the chameleon had greedily swallowed his prey without crunching it, and had been killed by the grasshopper kicking and injuring the stomach with its spiny legs. However, on taking up the apparently defunct reptile, it walked off in a dignified manner and ascended its branch.

Mr. Crowther, to whom I sent six of these chameleons, writes me that they were not very keen on beetles and flies, but would run for woodlice, were very fond of slugs but not much of snails, whilst mealworms they despised. Their attitude towards flies may be due to the fact that they were forcibly fed on these during the voyage home.

As already related elsewhere, chameleons have a very real enemy in siafu, which ascend the bushes at night. The chameleon, awakened by the biting little fiends, throws itself from the branch in an effort to escape, when it is set upon by the driver-ants below, which do not leave it till all the flesh is picked off its bones. I lost quite a number in the garden in this way.

It is most extraordinary to what extent a chameleon can hold on when it so desires. One was released on the balcony, and it sought freedom by departing on the telephone wire. I saw it just before dark clinging in a high wind to the swaying wire at a distance of 80 feet from the balcony and 20 feet from the ground. The following morning it finished the remaining 10 feet and descended the iron pole. I might say that I measured the 90 feet very carefully lest I should exaggerate in my enthusiasm for the performance.

Nematodes from one specimen have been determined doubtfully as *Physaloptera varani* Parona, as only females were found.

CHAMÆLEON BITÆNIATUS Fisch.

Blgr. Cat. Liz. iii. 1887, p. 452.

A single female from Kabare, 8. i. 23. Measured 71+60 mm. and held twelve eggs measuring 8 mm. in diameter.

CHAMÆLEON HOEHNELII Steind.

Steind. Sitz. Ak. Wien, 1891, p. 307, pl. i. fig. 1.

Two males from Kabete, Kenya Colony.

Tornier has made *hoehnelii* a var. of *bitæniatus* *, and Miss Procter, after examining the two specimens above, writes of *hoehnelii*:—"This appears to me to be a variety of *Ch. bitæniatus* Fisch. In *C. bitæniatus* there is a strong sexual dimorphism of the casque, which in the ♀ ♀ is low, and in the ♂ ♂ strongly raised and crested. The two Kabete males do not differ in any essential from males from the Aberdare Mtns., K.C., in the British Museum collection. The gular crest may also be low, or very greatly developed; likewise the dorsal, which is always arranged with every 2nd or 3rd spine the longest. One specimen of *Ch. hoehnelii* in the British Museum collection has every 3rd spine remarkably stoutly developed."

CHAMÆLEON JACKSONII var. VAUERESCECÆ Tornier.

Torn. Zool. Jahrb. Syst. xix. 1903, p. 176.
Love. P. Z. S. 1920, p. 163.

In my previous note on this three-horned chameleon I remarked that only four specimens were available of a large series collected, many of which remained at Nairobi. Shortly after I returned to East Africa, Miss Procter wrote me that a missing jar of reptiles which had been sent to the British Museum during the war had been found in another department. Amongst other things it contained ten of these specimens, to which I referred and wanted. Three ♀ ♀ were collected on 27. iii. 15 and received the same register number, viz. 3253. One of these (100 mm. long) and the male 3534 have already figured in my notes.

Miss Procter points out that in only half of the ♀ ♀ referred to in my tabulated list are the præorbital horns as long as the rostral, and the additional individuals now available contain four

* Tornier, Thier. Deutsch. O.-Afr. Rept. 1896, p. 51.

more ♀♀ which present an interesting link between *forma typica* and var. *vauerescecæ*, and nullify my contention that there is little foundation for saying that the præorbitals are much shorter than the rostral horn in ♀♀, but I think still show it is impossible to rely on their relative lengths as a guide to sex as Meek has suggested.

Miss Procter has given me the note she made on the specimens when they turned up, and I reproduce this below, together with the table which she drew up:—

Register Number	3809.	3534.	3543.	3545.	3253.	3253.	3253.	3687.
Sex	♂	♂	♂	♂	♀	♀	♀	♀
Length of head and body	113	91	81	96	103	100	94	94
Length of rostral horn	25	18	14	17	11	11	6	3
Length of præorbital horns	27	17–18	14	14	11 (1 only)	5–6	Represented by minute spines ·5 mm. long in both specimens as in *forma typica*.	

"Taking the species as a whole, the rostral horn is the one to develop first, and is in all cases stouter than the præorbitals. The præorbitals were evidently first developed in the ♂. In *forma typica* the ♂ has the three horns of equal length; these are represented in the ♀ by three short sharp spines (usually not more than 1 mm. long). In these Nairobi specimens the horns develop in the ♀ in a highly variable degree. The rostral always more or less developed; when the rostral is short the præorbitals are absent as in *forma typica*; when the rostral horn is long the præorbitals may be short, medium, *or equal in length* to the rostral. In one ♂ of var. *vauerescecæ* the præorbitals are actually *longer*, though still more slender, than the rostral, in another they are *shorter* as in the ♀. Var. *vauerescecæ* therefore differs from *forma typica* in the presence of a horn, or horns, of variable degree of development in the female."

CHAMÆLEON MELLERI Gray.

Blgr. Cat. Liz. iii. 1887, p. 472.

Three specimens. Two from Kilosa on 8. vi. & 8. ix. 22, of which one was on a low cocoanut-palm. The third was a half-grown individual from Kisanga, taken 24. ii. 23.

As I know of no description of the coloration in life, it may be as well to give that of one of these females. Snout a rich dark green; a vertical band of pale yellow from buccal border below eye extends upwards to postocular region, but not on to crest. A semicircular patch of pale yellow round forearm anteriorly. Four vertical bands of a rich dark green on body, first partly covered by posterior ends of occipital lobes, the second about mid-body bifurcates before reaching the dorsal crest and each arm of the fork again bifurcates on the crest, the third and fourth are similar to the second; the inter-band areas pale yellow or yellowish-green. Ten similar dark green bands on tail with yellowish interspaces much mottled with green. The tail, which is generally kept coiled, has a very peculiar appearance, as the bands coincide, giving the appearance of spokes in a wheel.

This description might be summarised by saying "General colour a rich dark green, with intermediate more or less complete vertical bands of yellow from subocular region to tip of tail."

When angry *C. melleri* gapes widely. The interior of the mouth is dark blue-black, corners of mouth blue, inner edges of lips pink. Two soft lobes of a lung-like appearance on inside of jaws near the front. The dark green bands become almost black, light yellow becomes vivid yellow, and the whole of head and body becomes sprinkled with black blotches, a particularly large one appearing just above the junction of the forearm.

The coloration of the Kisanga specimen in life was as follows:—General colour the palest of greens, almost white. A black spot below the occipital flap. Four vertical black bands on body, the first commencing just behind the forearm. Ten similar bands on the tail, each of the fourteen bands with a greenish-white spot dorsally. Limbs with three or more bands sometimes very indistinct. Though kept under observation for three months it never became a rich green (♀ 136+153).

At Mbala on 26.ii.23 five eggs measuring 22×17 mm. were found beneath a stone on a path. There may have been more, as they had been disturbed by natives when I found them. The embryos within measured 23+36 mm. and the hind-limb measured 16 mm. There were eight distinct vertical bars on the body and traces of more than eight on the tail.

One specimen on being killed was found to have the intestines choked by four calculi composed of insect remains.

47. On some New or Little-known Species of Acari.

By STANLEY HIRST, F.Z.S.

(Submitted for publication by permission of the Trustees of the British Museum.)

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(Text-figures 1–24.)

TRACHYTES ? AUSTENI, sp. n. (Text-fig. 1.)

Deutonymph. Body about twice as long as wide. Dorsal shield undivided, covering the entire dorsal surface. It is furnished with a slight median longitudinal ridge and a lateral ridge on each side, these three ridges uniting at the anterior end of the dorsum. Tube of *peritreme* reaching forwards on to the dorsal surface above the coxa of the first leg, and then bending back again to form a short loop. There are a number of small round platelets, each bearing a hair situated laterally on the soft integument between dorsum and venter. A pair of similar platelets is also present on the little triangular cone in which the body terminates anteriorly. The ventral plates are not quite like those of *T. sumatrensis* Zacher; the large anterior one (called sterni-metasterni-genitale by Zacher) has the lateral projection on each side opposite the interval between the second and third coxæ more angular than depicted by Zacher; whilst the *anal plate* is larger than in *T. sumatrensis*, almost touching the large anterior plate, and sometimes quite in contact with the coxal (metapodial), the latter being very well-developed. All the ventral plates are ornamented with minute spots, each composed of a group of punctations. Anterior ventral plate with five pairs of very short hairs. Anal plate with seven pairs of hairs, including two pairs situated near the anal aperture. Posteriorly there are several of the minute circular platelets, each carrying a short hair.

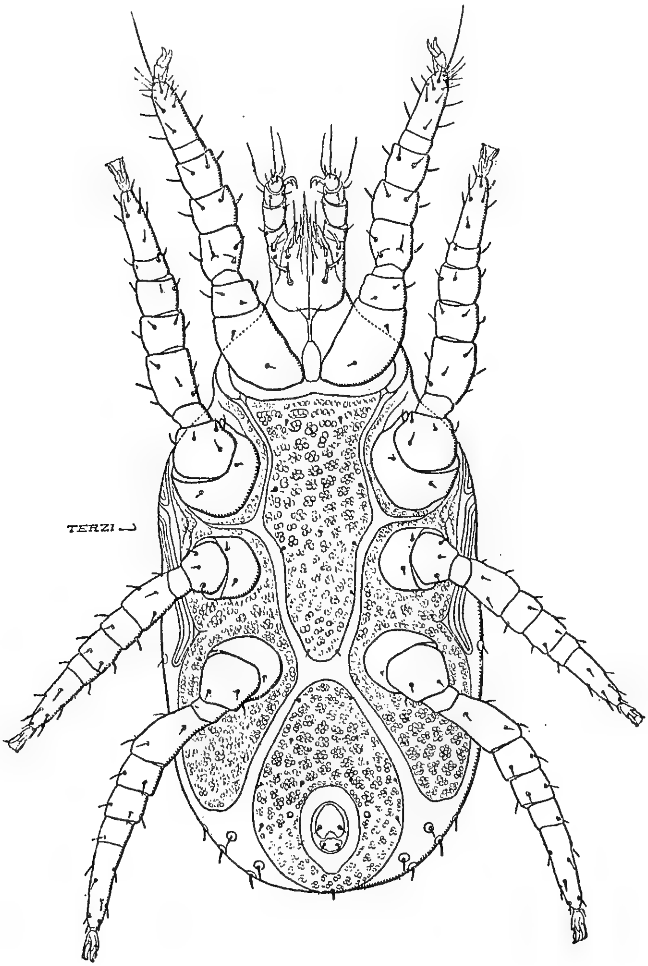
Length (including palpi) ·48 mm.; width ·22 mm.

Host: A large fly (*Pantophthalmus tabaninus* Thunb.); Brazil.

LÆLAPS UGANDANUS, sp. n.

♀. A large and very strongly chitinized species. *Sternal plate* very like that of *L. muricola* Trägårdh and *L. giganteus* Berlese; faint reticular markings are present on its surface. *Genito-ventral plate* widely expanded behind the coxæ as in *L. muricola*, etc.; apparently there are no linear markings on it. *Lateral platelet* near the last coxæ much larger than is usually the case in the genus *Lælaps* and curiously shaped, ending in a sharp, almost spiniform point anteriorly; its surface is ornamented with a rather irregular network of linear markings. Paired hairs on *anal plate* slightly longer and also more slender than the unpaired posterior hair. Hairs on venter numerous, most of them being short, but the lateral and posterior ones are somewhat longer; there are three pairs of quite long and fine hairs to the side of and behind the posterior end of the genito-ventral plate. Coxa

Text-figure 1.



Trachytes austeni, sp. n. Deutonymph. Ventral view.

of first leg with a short outer spine and a long inner seta, neither being stout. The spine or thorn on the second and third coxæ is not very thick; whilst that of the fourth coxa is short and quite slender.

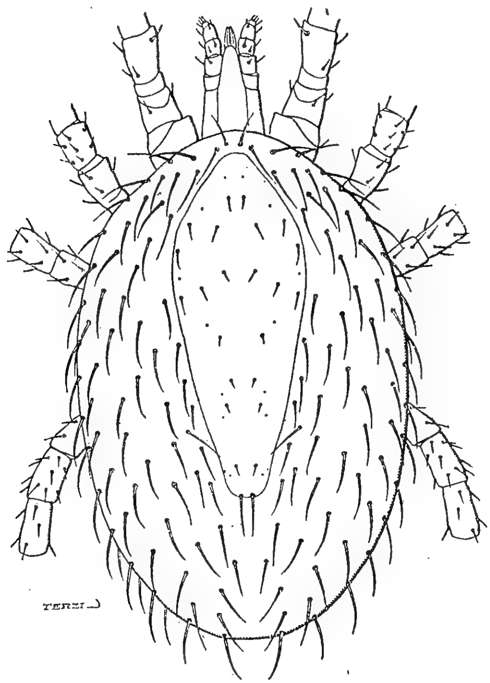
Measurements. Length of body (not including capitulum) 1820 μ; its width 1290 μ. Length of sternal plate 440 μ; its greatest width 420 μ, its least width 380 μ. Length of genito-ventral plate (including the operculum) about 760 μ; its greatest width 590 μ. Length of lateral platelet 195 μ; its width 142 μ.

Hab. Off a rodent, Bugwe, Bumungi, Uganda. Collected by W. N. van Someren (20. iv. 1922).

LIPONYSSUS GORDONENSIS, sp. n. (Text-figs. 2 & 3.)

♀. A single *dorsal shield* is present, being shaped as shown in text-figure 2. On the surface of this shield there are a number of very short fine hairs. In the anterior half these hairs are grouped together, but posteriorly they are fewer in number, apparently always being paired; the paired hairs at the extreme

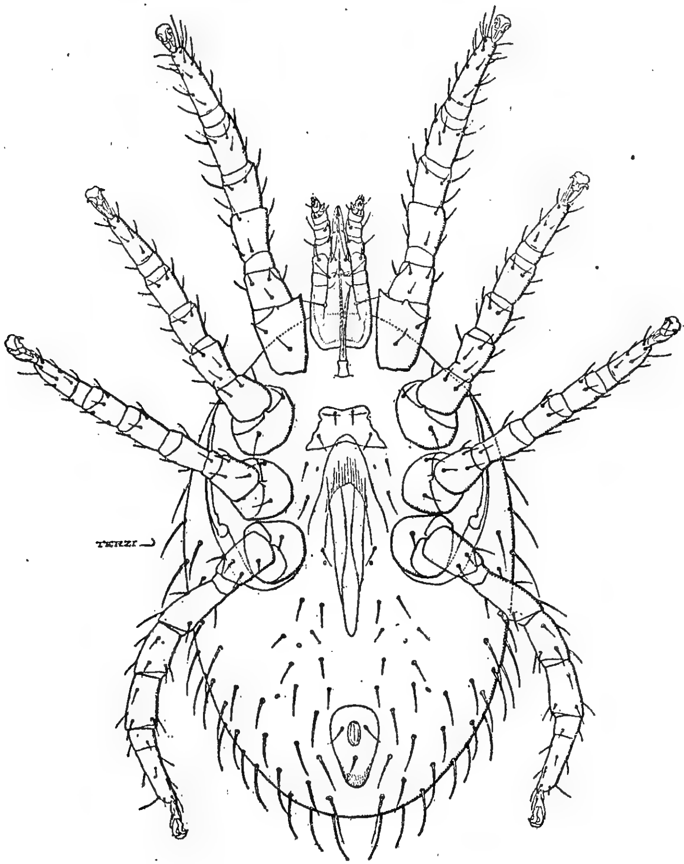
Text-figure 2.



Liponyssus gordonensis, sp. n., ♀. Dorsal view.

posterior end of the dorsal shield are much longer than the others. Hairs on softer uncovered part of dorsum not very long, but much longer than those on the dorsal shield (except the terminal pair on the latter), and they are curved as in *L. saurarum*, etc. *Sternal plate* trapezoidal and only furnished with two pairs of hairs; its posterior margin is not thickened. *Genito-ventral plate* narrow and its posterior end pointed. *Anal plate* pear-shaped and not so narrow as that of *L. saurarum*. Hairs on venter not very numerous, and much shorter and straighter than those on the dorsum. *Peritreme* extending as far forwards as the coxa of the second leg. Coxæ of *legs* without spurs. Legs

Text-figure 3.



Liponyssus gordonensis, sp. n., ♀. Ventral view.

furnished with numerous hairs, which are mostly slender, those on the ventral surface being very fine. There is a pair of somewhat thicker hairs or setæ on the dorsal surface of the femur of the first leg. *Chelicera* normal for the genus, its fingers not being provided with teeth.

Length (including palpi) ·68–·95 mm.; width ·35–·58 mm.

Host: A skink (*Mabuia quinquestriata* Lichtenstein); numerous specimens collected by the author on this host at Khartoum (Feb. 1923).

LIPONYSSUS SYLVIARUM Can. & Fanz.

Miss E. Knight, of the Lister Institute, has sent me a number of specimens of *L. sylviarum* found on hens at Bletsoe, Bedfordshire. The mites occur round the vents of the birds, and seem to multiply very rapidly. They form colonies, and do not leave the birds during the daytime, as is the habit of the common red mite of fowls (*Dermanyssus gallinæ* Redi). The tail-feathers, particularly the fluffy portion near the base, become covered with great numbers of mites. Later on, the parts of the skin attacked by the mites become raw, and a hard scab appears afterwards. Although previously found on Pigeons in this country, this is the first case of this mite becoming a pest of poultry here. In the United States a number of cases of *L. sylviarum* attacking hens are known, and it is regarded as a very injurious species, egg production of the infested birds being greatly reduced.

DERMANYSSUS (ALLODERMANYSSUS) SANGUINEUS Hirst.

This species was described from specimens found on *Rattus rattus* and other rodents in Egypt. It has also been recorded by Ewing as occurring in the United States (Proc. U.S. Nat. Mus. 1922, vol. 62, art. 13, p. 25). During February 1923, I collected a number of specimens of this mite from *Rattus alexandrinus* (grey-bellied form) and from *Mus musculus gentilis* at Khartoum, Sudan.

RHINONYSSUS (NEONYSSOIDES) NUCIFRAGÆ, sp. n. (Text-figs. 4 & 5.)

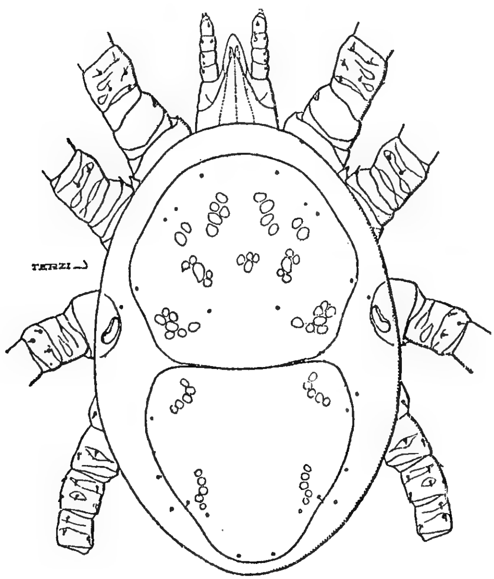
♀. Two large dorsal shields are present, covering practically the entire upper surface of the body instead of only a single anterior dorsal shield as in most species of *Rhinonyssus*. Apparently only one or two pairs of exceedingly short and inconspicuous hairs are visible on the dorsal shields; there are, however, also some very minute and inconspicuous circles on the shields; these minute circles no doubt represent the sockets of the hairs present in other forms. Hairs on *venter* also mostly obsolete or absent; when present they are exceedingly short and inconspicuous. *Sternal plate* indistinct. There is a clear space ventrally which probably represents the genito-ventral plate; it is wide and apparently rounded off posteriorly. *Anal plate* distinct and pear-shaped, bearing three very short hairs. *Peritreme* very short. Coxæ without spines or hairs, only minute circles being present. A few very short spinules occur on the proximal segments of the legs, and some longer fine hairs on their tarsi. There is also a fine hair on the dorsal surface of the penultimate segment of the anterior legs, and a fairly long and fine but rather stiff hair, which has its basal ring rather strong and conspicuous, is placed dorsally near the distal end of the tarsi.

♂. *Genital pore* anterior in position. *Anal plate* apparently narrower than in the female sex.

Measurements. ♀: length (including palpi) ·66–·70 mm.; width ·39–·40 mm. ♂: length (including palpi) ·66 mm.; width ·30 mm.

Host: *Nucifraga caryocatactes*; three female specimens collected by Herr Tischler at Heilsberg (5. ix. 1913) and a male from Ulmenhorst (12. x. 1911); Thienemann Coll.

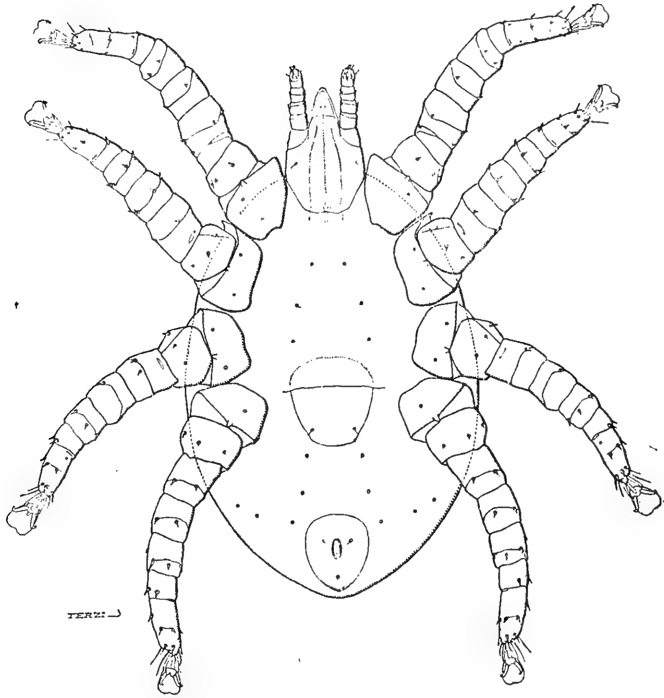
Text-figure 4.



Rhinonyssus (Neonyssoides) nucifragæ, sp. n., ♀. Dorsal view.

NOTE.—Owing to the presence of two dorsal shields instead of a single anterior one, as is usually the case in *Rhinonyssus*, it is necessary to place this species in a new subgenus—*Neonyssoides*. *Rhinonyssus* (*Neonyssoides*) *nucifragæ* resembles *Neonyssus intermedius* Hirst in having two dorsal shields and also most of the hairs replaced by minute circles, differing from the latter in the shape of the ventral plates, presence of distinct spinules on the legs, etc.

Text-figure 5.



Rhinonyssus (*Neonyssoides*) *nucifragæ*, sp. n., ♀. Ventral view.

Key to the species of Ancystropus *present in the British Museum Collection.*

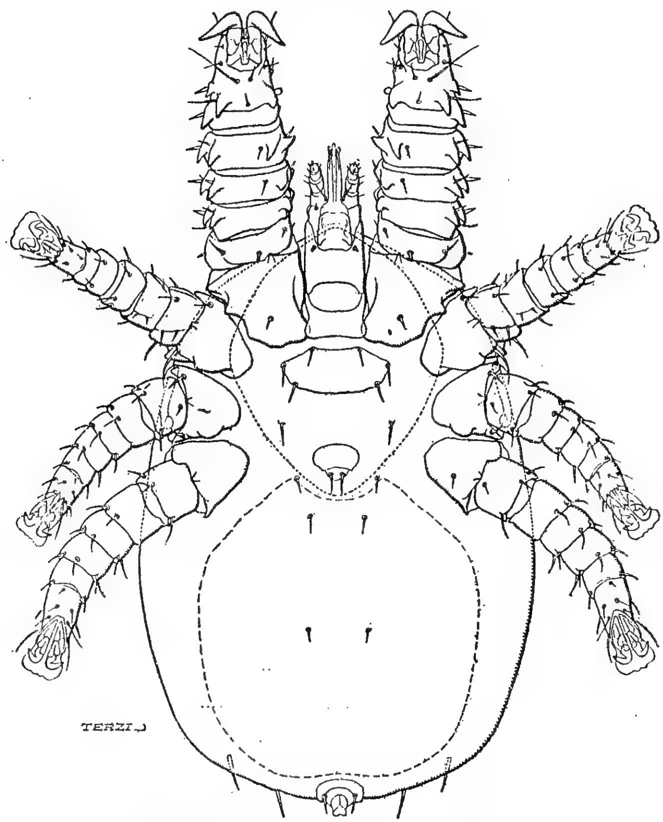
1.	Pulvillus of legs obsolete or absent	2.
	Pulvillus of legs well-developed...........................	3. (Subgenus *Meristaspis* Kolenati.)
2.	Sternal plate much wider than long; the two rows of dentiform processes on posterior surface of first leg strongly developed	*A. zelebori* Kolenati.
	Sternal plate only slightly wider than long; the two rows of processes on posterior surface of first leg much weaker	*A. æthiopicus*, sp. n.?
3.	Posterior spurs of coxæ obsolete. Hypostome short, rather stout, the barbules unusually large	*A. macroglossi*, sp. n.
	Posterior spurs of coxæ better developed. Hypostome shaped otherwise	4.
4.	Posterior spur of first coxa long.............................	*A. calcaratus*, sp. n.
	Posterior spur of first coxa much weaker	*A. lateralis* Kolenati.

Ancystropus zelebori Kolenati. (Text-fig. 6.)

Ancystropus zeleborii Kolenati, Parasiten der Chiropteren, 1856, p. 25.

♀. *Dorsal shield* not very long, and its posterior end is wider and blunter than in *A. lateralis*, etc. *Peritreme* very short, being restricted to the dorsal surface. There is a very strongly

Text-figure 6.



Ancystropus zelebori Kolenati, ♀. Ventral view.

chitinized structure at the base of the capitulum ventrally which seems identical with the *jugular plaque*, but it is coalesced laterally with the capitulum instead of being free; it has distinct and rather wide auriculæ posteriorly much as in some ticks. *Sternal plate* situated far forwards, being placed just behind the base of the capitulum; it is shorter than in the other known species of *Ancystropus*, being much wider than long.

Process on dorsal surface of *capitulum* well-developed and conical. Hypostome rather long and slender. First *leg* greatly enlarged; its claws very large; the pulvillus very much reduced in size, being obsolete. Lateral setæ of this leg shorter than in *A. lateralis*; there are two rows of strong backwardly-directed denticles on the posterior and postero-ventral surfaces of the first leg, also a few projections on the anterior (inner) surface, and one or two rather strong ventral tooth-like projections. First coxa with the spur on its posterior margin poorly developed; second and third coxæ each with a slight lobe-like spur posteriorly, these spurs being weaker than in *A. lateralis* and *A. calcaratus*.

Length of body (not including capitulum) ·73 mm.; its width ·51 mm.

Host: Kolenati states that either *Rhinopoma microphyllum* or else *Pteropus ægyptiacus* is the host of this species of mite. I have only seen a single example, ex Kolenati's collection.

ANCYSTROPUS ÆTHIOPICUS, sp. n.? (Text-figs. 7 & 10 *a* & *c*.)

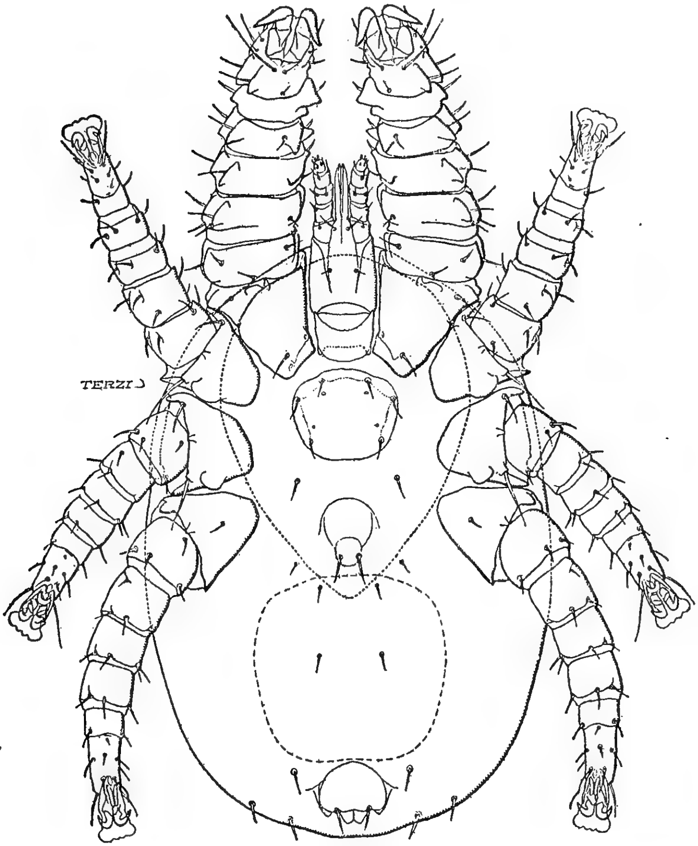
♀. Apparently the *dorsum* is not divided into two portions by a transverse line in this species. Dorsal shield (scutum) shaped as shown in text-fig. 7 (the dotted line). Hairs on anterior margin of dorsum very short. The pair of hairs present just behind the posterior end of the scutum in *A. lateralis* is missing in *A. æthiopicus*. *Sternal shield* larger than in *A. zelebori* Kolenati, and its shape is quite different. Process on dorsal surface of capitulum conical.

The strongly chitinized internal portion of the *jugular plate* varies considerably in shape in specimens of this mite from different localities; the posterior margin of this internal part is strongly concave in the examples from Damba Island, Lake Victoria, the posterior angles (auriculæ) being large and strongly produced; whereas in specimens from the Gambia the posterior margin is almost straight, the auriculæ being practically absent; the typical specimen from Zanzibar is rather intermediate in this respect, the posterior margin of this part of the plaque being somewhat concave with well-developed auriculæ. *Hypostome* slender and fairly long. *Palp* rather short and fairly stout. First *leg* much enlarged as in *A. zelebori*, but the backwardly-directed little chitinous processes on the posterior side of this limb are weaker than in that species; those of the lower row are sometimes distinct and dentiform, being especially well-developed in examples from Damba Island, Lake Victoria; but those of the upper row are quite weak; one or two of the processes on the anterior surface of this leg are large, however. Claws of first leg apparently rather smaller than in *A. zelebori*; the pulvillus obsolete. Posterior spur of first coxa obsolete; second and third coxæ each with a distinct lobe-like posterior spur; a weak pointed posterior spur may also be present on the fourth coxa. Hairs on dorsal surface of legs shorter and finer than in *A. lateralis* and also smoother, the accessory hairlets being obsolete.

Length of body (not including capitulum) ·94 mm.; its width ·65 mm.

Host: A fruit-bat (*Epomophorus minor*) from Zanzibar; a single specimen (the type) from this host. Also specimens probably referable to the same species of mite from the following hosts and localities:—*Micropteropus pusillus*, Gambia (*Dr. P. Rendall*). From a fruit-bat, Damba Island, Lake Victoria (*Dr. G. D. H. Carpenter*).

Text-figure 7.



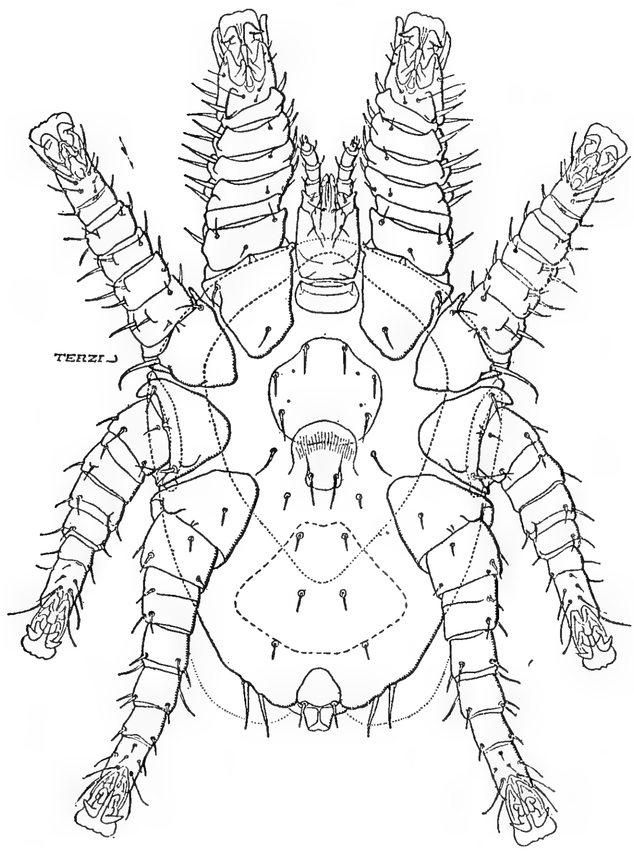
Ancystropus æthiopicus, sp. n.? ♀. Ventral view.

NOTE.—It is possible that Kolenati's *A. mulleri* from *Pteropus vulgaris* (= *Pteropus niger*?) is allied to the species described above under the name *A. æthiopicus* or perhaps even identical with it. The bat, *Pteropus vulgaris*, however, only occurs in the Mascarenes, Réunion, and Mauritius.

Ancystropus (Meristaspis) macroglossi, sp. n. (Text-figs. 8, 9, & 10 *b*.)

♀. Dorsal surface not divided into two divisions, but there is a short transverse line situated just behind the pointed posterior end of the *scutum*; the latter is shaped very much like that of *A. lateralis*. Number and distribution of hairs on dorsal surface

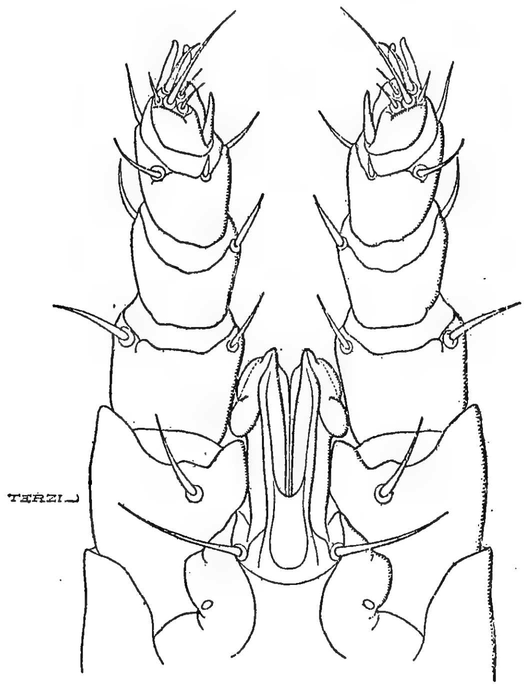
Text-figure 8.



Ancystropus (*Meristaspis*) *macroglossi*, sp. n., ♀. Ventral view.

exactly the same as in *A. lateralis*. *Jugular plaque* well-developed and transversely elongated, being even wider than in *A. lateralis*. *Sternal plate* smooth and shaped as shown in text-fig. 8; there are three pairs of hairs on its surface and also the usual two pairs of minute punctations. *Genital operculum* situated just behind the sternal plate, its anterior margin overlapping the hinder margin of the latter. *Genito-ventral plate* very similar to that of *A. lateralis* but wider, and furnished with a pair of hairs as in that species. Posteriorly there is also a somewhat triangular smooth area of the integument. Hairs on venter not numerous. There is a pair of hairs or setæ on each side of the posterior end of the body as in *A. lateralis*, but they are longer than in that species. Process on dorsal surface of *capitulum* stout and conical. Hypostome rather short, comparatively thick, and with the terminal barbules exceptionally well-developed. First (proximal)

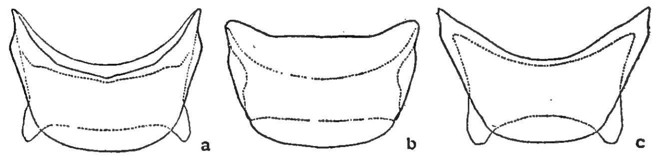
Text-figure 9.



Ancystropus (*Meristaspis*) *macroglossi*, sp. n., ♀. Palpi and hypostome, greatly enlarged.

segment of *palp* with the outer angle projecting and almost tooth-like. First *leg* thickened much as in *A. lateralis*, and furnished with rather similar lateral setæ and a pair of paddle-shaped terminal setæ as in that species. The chitinous processes present on the posterior surface of the first leg in *A. lateralis* are obsolete in this new species, and those usually present on the inner surface are also obsolete or absent; the anterior edge of the ventral surface of each of the segments of this leg is concave, however, and produced laterally so as to be almost dentate. Claw of first leg small; the pulvillus present. Some of the hairs on the dorsal surface of the legs are long. Hairs on ventral surface of legs very few in number. First coxa apparently without any posterior spur; the lobe-like spurs on the posterior margins of

Text-figure 10.



a. Jugular plate of *Ancystropus æthiopicus* (specimen from Zanzibar).

b. Jugular plate of *Ancystropus macroglossi*.

c. Jugular plate of *Ancystropus æthiopicus* (specimen from Damba Island, Lake Victoria).

the second and third coxæ are very slight, being almost imperceptible.

Length of body (not including capitulum) ·63 mm.; its width ·54 mm.

Host: *Macroglossus minimus*; Gilolo.

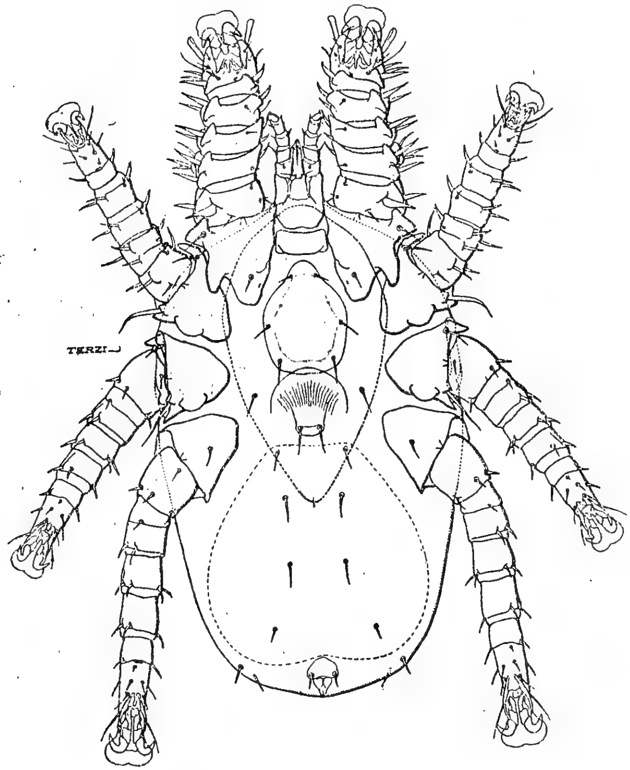
We have only a single specimen of this new mite in the collection.

Ancystropus (Meristaspis) calcaratus, sp. n. (Text-fig. 11.)

♀. The whole dorsal surface is rather strongly chitinized, and it is difficult therefore to see the outline of the scutum itself. There are a number of shallow pits on the surface of the scutum. Chætotaxy of dorsum much as in *A. lateralis*, but the hairs seem shorter. Process on dorsal surface of *capitulum* rounded instead of conical as in *A. lateralis*, etc. *Jugular plaque* strongly chitinized and elongated transversely, being much wider than long. *Sternal plate* almost flask-shaped, for it is roughly oval in shape, with a short anterior neck-like portion. It is smooth, being without markings, except for two pairs of minute punctations, and there are three pairs of hairs on it. *Genito-ventral plate* very short, rounded off posteriorly and bearing a pair of hairs. Hairs on *venter* very sparse as in *A. lateralis*, and although quite short they are longer than in that species. In unmounted specimens there is sometimes a slight but noticeable swelling on each side of the venter just before the posterior end of the body. Paired spines or hairs at posterior end of body minute and inconspicuous, being much smaller than in *P. lateralis*. First *leg* enlarged; the lateral setæ are very like those of *A. lateralis*, and there is a terminal pair of paddle-shaped setæ as in that species.

Denticles on postero-ventral surface of this leg also very like those of *A. lateralis*, but stronger, the anterior margin of the ventral surface of the segments of this leg being strongly concave. There is a stout spinule ventrally on each side of the distal end of the first tarsus, close to the origin of the claws. Claws of first leg not very large; the pulvillus present. Spur on coxa of first leg much longer than in the other known species of the genus. Second and third coxæ each with a lobe-like posterior spur.

Text-figure 11.



Ancystropus (Meristaspis) calcaratus, sp. n., ♀. Ventral view.

There are a number of rather long hairs on the dorsal surface of the legs; a pair on the femur of the first leg is the longest, the outer hair being the longer of the two.

Length of body (not including capitulum) ·70—about ·94 mm.; its width ·53–·61 mm.

Host: A large flying-fox (*Pteropus* sp.); Rook Island, August 1913 (*A. S. Meek*), ex Hon. N. C. Rothschild's coll.

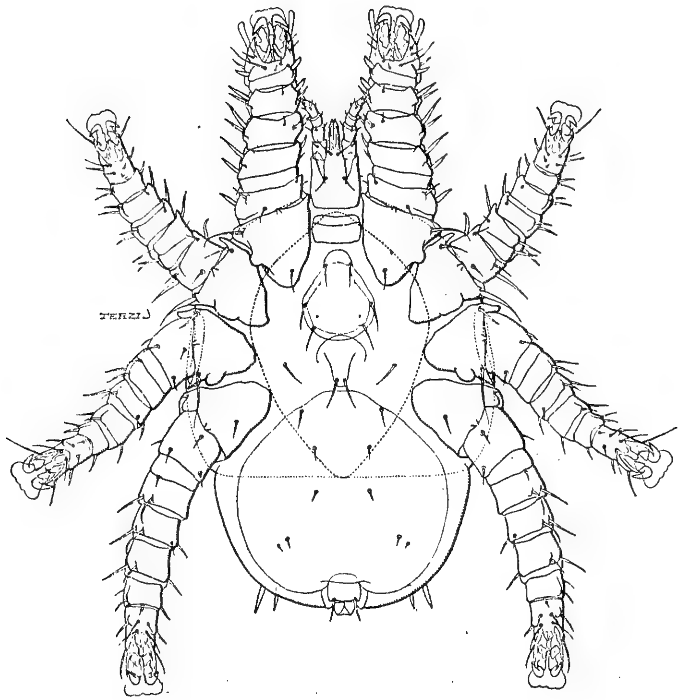
ANCYSTROPUS (MERISTASPIS) LATERALIS Kolenati. (Text-figs. 12 & 13.)

Pteropus lateralis Kolenati, Parasiten der Chiropteren, 1856, p. 29.

Meristaspis lateralis Kolenati, Sitzb. K. Ak. Wien, 1858, xxxiii. p. 84.

♀. *Dorsum* divided into a large anterior and a shorter posterior portion by a well-defined transverse line, situated just above and behind the last pair of legs. *Dorsal shield* ill-defined,

Text-figure 12.

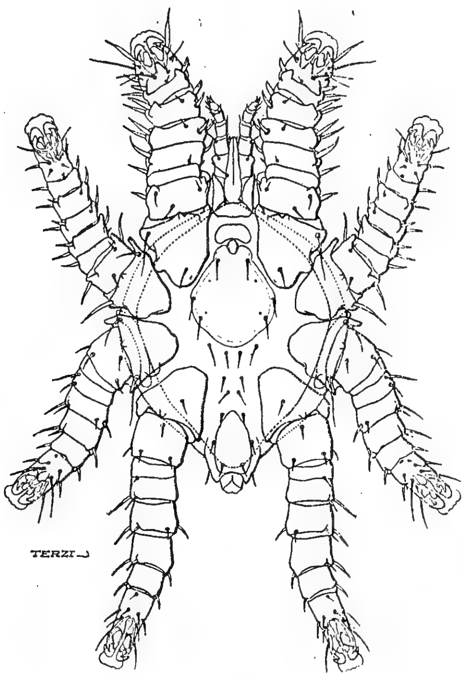


Ancystropus (*Meristaspis*) *lateralis* Kolenati, ♀. Ventral view.

but shaped as shown in text-fig. 12, the posterior end being rather sharply pointed. This shield reaches backwards as far as the transverse line. Hairs on dorsum short and few in number; there are several hairs near the anterior and antero-lateral margin, viz. a median pair and three hairs on each side a little further back, also a hair on each side opposite the gap between the third and fourth legs. On each side of the pointed posterior end of the scutum there is a short hair. There is also a pair of very short hairs a little behind the middle of the posterior part of the dorsum. Apparently there are no hairs on the scutum itself, only minute punctations. Process on dorsal surface of capitulum conical, pointed, and backwardly directed.

Jugular plaque well-developed, being strongly chitinized, much wider than long, and practically rectangular. *Sternal plate* shaped as shown in figure; it is very like that of some species of *Spinturnix*, the anterior end being narrowed; this plate has a narrow marginal strip of paler and weaker chitin; the surface is smooth, being without any markings, except two pairs of minute

Text-figure 13.



Ancystropus (*Meristaspis*) *lateralis* Kolenati, ♂. Ventral view.

punctations; there are three pairs of marginal hairs. Hairs on *venter* very few in number; there is a pair on the hinder margin of the minute *genito-ventral plate*. Behind this plate on the rest of the venter there are only four or five pairs of very short hairs, and they are well separated from one another. Part of the venter is very smooth, being devoid of the usual linear markings, and perhaps this area represents an obsolete plate. On each side at the posterior end of the body there is a pair of characteristic rather stout stiff setæ. *Hypostome* slender, the terminal barbules fairly well-developed. First pair of *legs* greatly enlarged, much as in *A. zelebori*; the lateral setæ of this leg much better developed than in that species, being rather stout and projecting sideways and slightly forwards; on each side of the distal end of this leg there is a paddle-shaped seta, its tip being flattened and truncated. At the base of each of the lateral setæ there is a curious projection ending both proximally and distally in an angular process or tooth, partly formed or at least accentuated by the concave distal margin of the ventral surface of the segment. Similar projections may occur also on the inner surface of the first leg. The upper lateral row of denticles present in *A. zelebori* seems to be absent in the present species and also in *A. calcaratus*, sp. n. Claws of first leg not very large; pulvillus present. Coxæ 1–3 each with a lobe-like spur on the posterior margin. A pair of very long hairs is present dorsally on the femur of the first leg and another shorter pair on the patella; similar but shorter hairs are also present on the same segments of the second and third legs; the trochanter of the third leg also has a rather long dorsal hair. A rather long dorsal hair is present also on the trochanter, femur, patella, and tibia of the fourth leg. All these long hairs have very minute accessory spinules or hairlets, causing them to have a slightly roughened appearance. Lateral hairs of legs stiff, plain, and not very long.

♂. *Scutum* covering the entire dorsal surface. *Jugular plaque* with the posterior margin somewhat concave. *Sternal plate* very like that of the female, but with the usual anterior genital pore. The pair of hairs at the distal end of the tarsus of the first leg are not paddle-shaped, their tips being finely pointed. Spurs on coxæ not so well-developed as in the female.

♀. *Length* of body (not including capitulum) ·70–·79 mm.; its width ·53–·56 mm.

♂. *Length* of body (not including capitulum) ·50 mm.

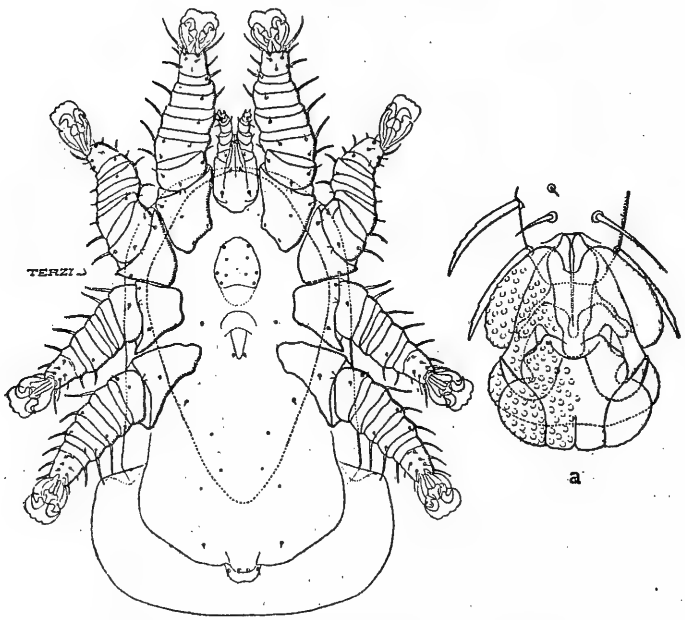
Host: A fruit-bat (*Rousettus ægyptiacus*). I have examined the cotype deposited in the Brit. Mus. Collection by Kolenati; also specimens from Rehoboth and Jaffa, Palestine, Jan. 1912 and Feb. 1920 (*J. Aharoni*), and examples from Cyprus, collected by Miss D. M. A. Bate.

PERIGLISCHRUS INTERRUPTUS Kolenati. (Text-figs. 14 & 15.)

Pteroptus interruptus Kolenati, Die Parasiten der Chiropteren, 1856, p. 29; *Pteroptus hipposideros* Kolenati, *t. c.* p. 29; *Periglischrus interruptus* Kolenati, Sitzb. K. Ak. Wiss. Wien, 1858, xxxiii. p. 80; *Periglischrus hipposideros* Kolenati, *t. c.* p. 82; *Periglischrus glutinimargo* Kolenati?, *t. c.* p. 80.

♀. A small species with the posterior end peculiar in shape, being wider than the rest of the body and flattened dorso-ventrally, forming a kind of rim. The weak *sternal plate* apparently has no hairs on its surface, but there are three pairs of minute circles on it near the lateral margins, and sometimes also two additional pairs of rather indistinct circles situated nearer the middle of the plate. *Genital operculum* very small and situated between the third coxæ. *Genito-ventral plate* very small, narrow and wedge-shaped in outline, the posterior end being pointed. *Peritreme* very short. Hairs on venter few in number and exceedingly minute and inconspicuous. There is a pair just behind the posterior end of the genito-ventral plate and also three pairs at the posterior end of the venter. There are also a

Text-figure 14.

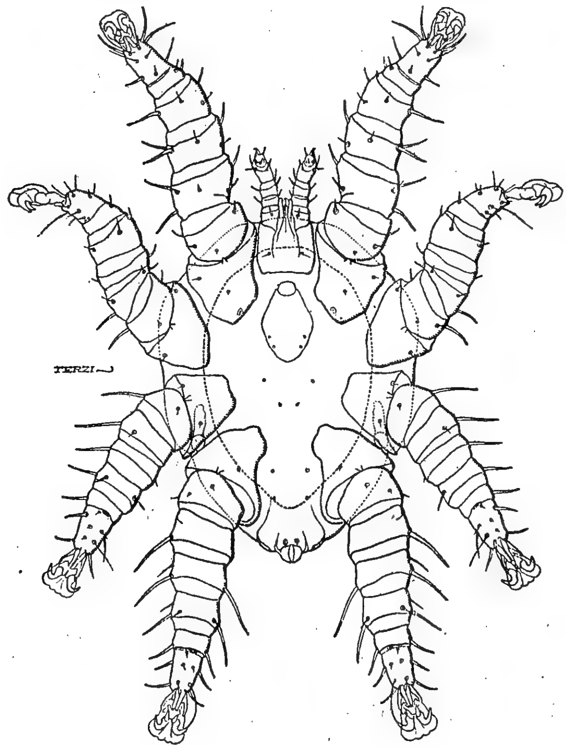


Periglischrus interruptus Kolenati, ♀. Ventral view.
a. End of tarsus of leg of same showing pulvillus.

number of minute circles which do not seem to be provided with hairs. Coxæ of legs without spurs; they are rather curiously shaped (see text-fig. 14), the outer posterior angle of the third coxa being strongly chitinized and projecting somewhat, whilst the same part of the fourth coxa forms a long narrow strip. Numerous hairs and setæ of moderate length are present on the dorsal surface of the legs, including a noticeably long hair on the femur and another on the patella of the first leg. Ventral surface of legs almost hairless, except the tarsi which bear a number of hairs. Pulvillus of legs peculiar in shape; there is a well-developed additional lobe or expansion on each side of the basal support of the claws, besides the usual terminal lobes (text-fig. 14 *a*).

♂. Sternal plate shaped as shown in figure; there are two pairs of minute circles situated near the lateral margins posteriorly. Hairs on venter either short or replaced by minute circles. Coxæ without spurs. The two modified setæ placed near the distal end of the penultimate segment of the palp are quite long.

Text-figure 15.



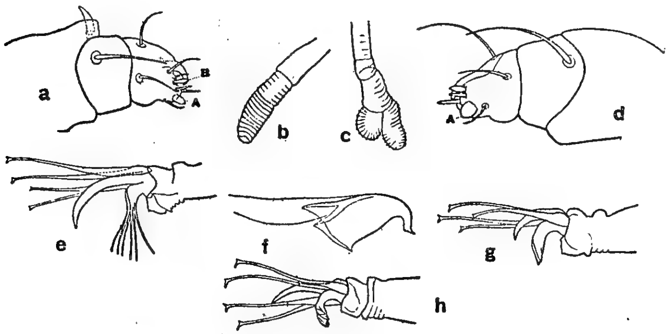
Periglischrus interruptus Kolenati, ♂. Ventral view.

Hosts and localities. Kolenati gives *Rhinolophus clivosus* [= *R. blasii*] as the host of *Periglischrus interruptus* in his 'Parasiten der Chiropteren,' but later in Sitzb. Ak. Wiss. Wien gives *R. euryale*, allotting a new name—*P. glutinimargo*—to a mite of this genus from Egyptian specimens of *R. clivosus*. In addition to Kolenati's cotypes of *P. interruptus* and *P. hipposideros*, the British Museum possesses examples from *Rhinolophus* *euryale*, Grotto of Pietralbello, Pontelecchia, Corsica (collected by S. Hirst, 17. iii. 1922), and from the same host at Ajaccio (S. Hirst, 5. iii. 1922).

PARATETRANYCHUS INDICUS, sp. n. (Text-fig. 16.)

♂. *Palp* with the terminal finger (A in text-fig. 16 *a*) stout, but rather short, being shorter than the stiff rod-like setæ situated near it. Dorsal sensory finger (B in text-fig. 16 *a*) club-shaped and about as long as the terminal finger. When seen from the side, the ventral part of the claws of the anterior *legs* seems to be a strong curved claw-like process, but if examined carefully, it is seen to be subdivided into several parallel teeth, which are rather stout in the case of the first leg, those of the second leg being weaker. Ventral part of claw of posterior legs

Text-figure 16.



Paratetranychus indicus, sp. n.

a. Palp of male. *b* & *c*. End of collar trachea showing variation in shape. *d*. Palp of female. *e*. Claw of posterior leg of male. *f*. Penis. *g* & *h*. Claws of anterior legs of male.

divided into six quite fine hairs as in all the legs of the female sex; the dorsal claw-like part is longer than in the anterior legs. The hard chitinized part of the *penis* is short and strongly curved, its end being shaped rather like that of *T. telarius* (= *T. althææ* of Hanstein, Zacher, and some other recent authors), one of the barbs being quite weak.

♀. *Body* elongate-oval, the body + the head-plate being about twice the greatest width of the former. Terminal finger of palp (labelled A in figure *d*) of female short and very wide. Collar trachea normally ending in a single elongated terminal cell (text-fig. 16 *b*); in one specimen, however, the end consists of two cells lying side by side, one being more elongated than the other (text-fig. 16 *c*). Claws of legs of female similar to the posterior ones of the male, consisting of a long slender dorsal part and a ventral projecting portion split into six fine hairs.

Measurements. ♂ : length (including palpi) ·33 mm.; greatest width ·147 mm. ♀ : length (including palpi) ·51–·54 mm.; greatest width ·235 mm.

Host-plant: Sorghum, India. Mr. Y. Ramachandra Rao, of the Coimbatore Agricultural College, informs me that this mite is sometimes a serious pest of Sorghum or cholam (*Andropogon sorghum*). It is found in large colonies under the surface of the leaves and increases rapidly in numbers. The attacked portions turn bright red as if attacked by rust. The mite is greyish green in colour when alive.

TETRANYCHUS CRATÆGI Hirst.

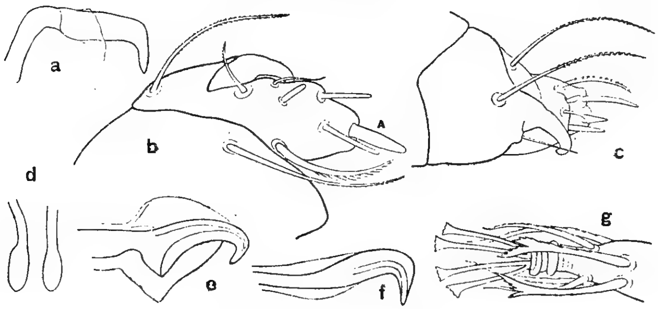
F. Zacher asserts (Mitt. Biol. Reichs. f. Land- u. Forst. Berlin, Heft 21, Dec. 1921, p. 91) that the species of Red Spider described by myself under the name *Tetranychus cratægi* is a synonym of his *Tetranychus viennensis*. The description of *T. cratægi* was published in the Proc. Zool. Soc. July 1920, whereas that of *T. viennensis* was published in Zeitschr. angew. Entom. Berlin, vii. No. 1, September 1920. It will be seen that *T. cratægi* has the priority and that *T. viennensis* is the synonym. It is true that Zacher had circulated an earlier typewritten document which does not bear the impression or stamp of any Society or publisher, nor even the name of the place at which it was issued. It bears the date "17. Mai 1920" and is entitled "Vorläufige Diagnosen einiger neuer Spinnmilbenarten." There are several corrections in pencil in the copy in my possession. It is quite evident that this document does not constitute publication and that the three new species mentioned in it are not valid; in fact, it would seem that Zacher realises that this is so himself, for he redescribes all three species as new at a later date in Zeitschr. angew. Entom. Berlin, as mentioned above.

ANYCHUS LATUS Can. & Fanz.? (Text-figs. 17 & 18.)

♂. Collar tracheæ of a simple type (see text-fig. 17 *d*), ending in a single long cell. Hairs or setæ on dorsum twenty-six in number (not including the finer hairs near the anus); these dorsal hairs are stiff, being rod-like and slightly pectinated. Penis shaped as shown in figure, being strongly curved and claw-like. *Palp* with the terminal sensory finger represented by a conical spine, which is only about half the size of the two usual stiff red-like setæ present close to it; dorsal sensory finger short and slender.

Tarsi of *legs* apparently without any claw, but the usual tenent hairs, which are four in number in the male of this species, are present, being situated on a short peduncle. Besides the ordinary rather long and slightly-feathered hairs on the legs, there are a few modified and sensory hairs. Dorsally near the apex of the tarsi there is a curved hair or seta with the end enlarged, being flattened and pectinated. There appears to be only one of these hairs on the anterior tarsi, but there are two on the third tarsus. There are several short, stiff curved rod-like sensory hairs (sinneskolben) at the distal end of the anterior tarsi; four of these sensory setæ are also present on the penultimate segment of the first leg, two dorso-lateral ones posteriorly and another anteriorly, and one ventral in position. Besides the short distal sensory setæ on the second tarsus, there is also one rather near the proximal end; whilst there are two on the penultimate segment of this leg. Tarsus and also the penultimate segment of the posterior legs each usually with a short, stiff sensory seta near the proximal end, but that on the penultimate segment of the fourth leg may be absent.

Text-figure 17.



Anychus latus Can. & Fanz.?

a. Penis. *b.* Palp of female. *c.* Palp of male. *d.* End of collar trachea. *e* & *f.* Penis. *g.* End of a leg.

♀. Terminal sensory finger of palp fairly well-developed, being peg-shaped and almost as long as the longer of the two rod-like setæ situated close to it. Dorsal sensory finger not very long, but slender and practically cylindrical.

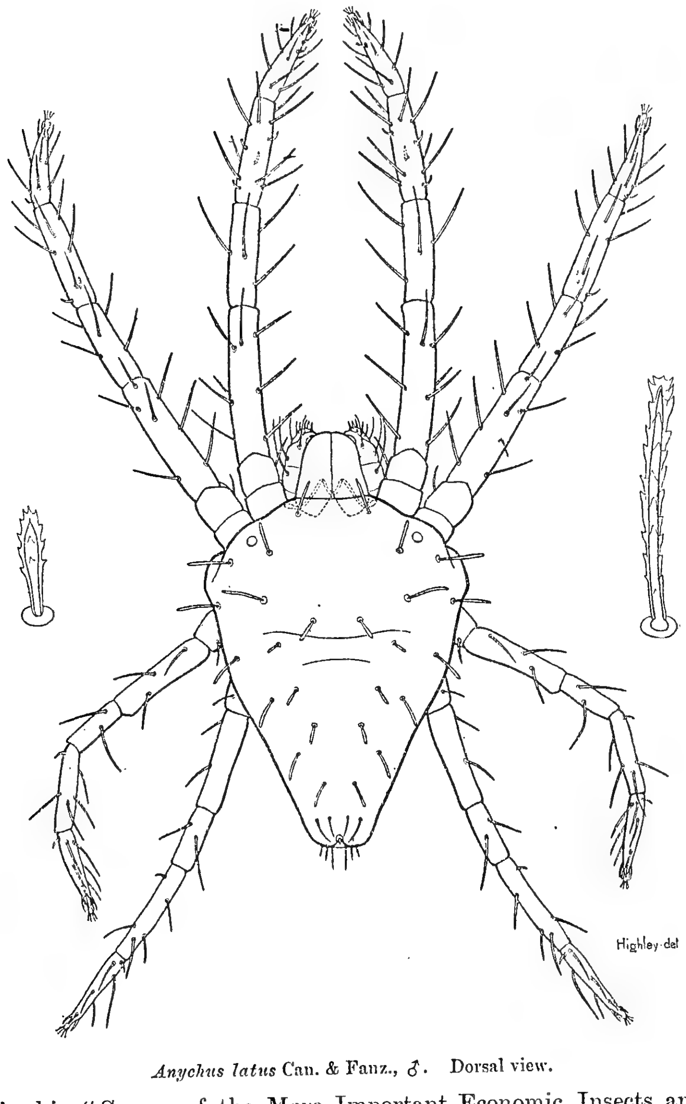
♂. *Length* of body (including palpi) ·375 mm.; its greatest width ·192 mm.

♀. *Length* of body (including palpi) ·437 mm.; its greatest width ·304 mm.

Plant-hosts: Lebbek-trees at Wadi Halfa; specimens collected by S. Hirst (25. i. 1923). Also specimens from a leguminous tree or shrub at Makwar, near Sennar, Blue Nile, Sudan (9. ii. 1923), collected by S. Hirst.

Note.—The finer structural details are not all given in Canestrini's and Berlese's figures of *A. latus*, so that I have some doubt in referring my specimens from North Africa to this species, but I think that this identification will prove to be correct. It is possibly also the same as the mite mentioned by F. C. Willcocks under the name *Bryobia* sp. (Lebbek Red Spider)

Text-figure 18.



Anychus latus Can. & Fanz., ♂. Dorsal view.

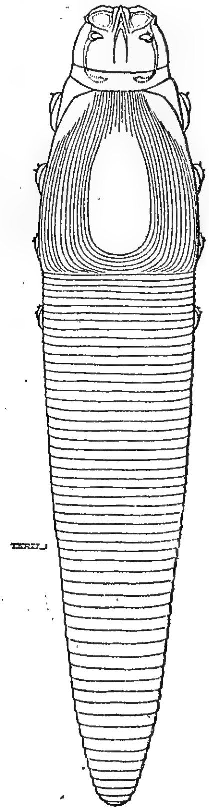
in his "Survey of the More Important Economic Insects and Mites of Egypt," Bulletin No. 1, Sultanic Agricultural Society, p. 266 (1922).

DEMODEX SCIURINUS, sp. n. (Text-fig. 19.)

Variety of *D. melesinus*?

♀. Body about five times as long as the greatest width of the cephalothorax. Abdomen longer than the combined length of capitulum and cephalothorax. Capitulum not much wider than long. Striations on dorsal surface apparently all longitudinal in direction, the convoluted pattern present in *D. melesinus*

Text-figure 19.



Demodex sciurinus, sp. n., ♀. Dorsal view.

apparently being absent. Spinules on capitulum very minute as in *D. folliculorum* and *D. melesinus*, but not so short as in the latter. Distal part of capitulum sharply angular and salient laterally.

Measurements. Total length of body 165 μ; length of cephalothorax and capitulum 67 μ; of abdomen 98 μ. Greatest width of cephalothorax 33 μ; of abdomen 29 μ; of capitulum (at base) 22 μ; length of capitulum 18 μ.

Host: Brown Squirrel (*Sciurus vulgaris*). A specimen of this mite was collected from a squirrel received from Inverness, 21. iv. 1922.

TARSONEMUS TRANSLUCENS Green.

This mite has already been recorded as occurring on tea in Ceylon and India, and also described by myself from specimens found on *Capsicum* in Trinidad (*F. W. Urich Coll.*). Professor G. S. Kulkarni has brought to the Museum specimens found on potatoes at Poona. He states (Agric. Journ. India, vol. xvii. part 1, Jan. 1922, pp. 51–54) that this mite is the cause of the very serious "*Murda*" disease of Chilli (*Capsicum*) and also of the "*Tambera*" disease of potatoes in India.

TARSONEMELLA, subgen. nov.

Closely allied to *Tarsonemus*, but the legs of the first pair stouter than the others and without pulvillus. Also the pseudostigma normally present between the first two pairs of legs in *Tarsonemus* is absent. Fourth leg of female modified in a similar way to that of the typical *Tarsonemus*, the terminal segments being attenuated and ending in a long hair.

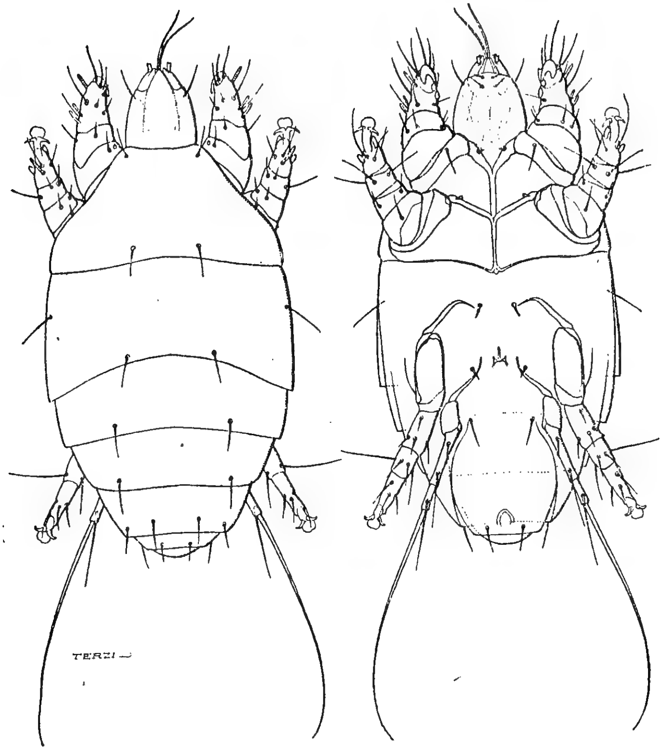
TARSONEMUS (TARSONEMELLA) AFRICANUS, sp. n. (Text-figs. 20 & 21.)

♀. Shape rather elongate-oval, the body being much longer than wide. Tarsus of first leg with a well-developed but not very large claw, which is slender, curved, and sharply pointed. Dorso-laterally near the distal end of this tarsus there is a slender, striated cylindrical seta of fair length, and near the middle there are two similar but smaller setæ, one of which is very slightly clavate. Two or three stiff hairs with broken-off ends like those present on the same segment in *Pseudotarsonemoides spiritarsus*, sp. n., also occur on the first tarsus. Tarsus of the second leg with a striated seta dorsally of about the same size as the longest one on the first tarsus, and also a shorter and stouter seta on its posterior side. Tarsus of second and third leg with a pulvillus and paired claws. Hairs on body short, especially the ventral ones; owing to the fact that the specimens of this mite are mounted in balsam, it is difficult to be certain of the exact number and distribution of these hairs.

Length (including capitulum) 200 μ.

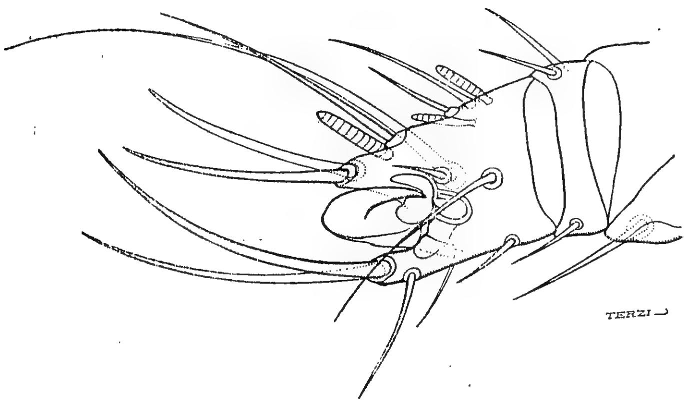
Host: A hymenopterous insect (*Agaon xystrum* Waterston); from Koforidua, Gold Coast (4. iv. 1921).

Text-figure 20.



Tarsonemus (*Tarsonemella*) *africanus*, sp. n., ♀. Dorsal and ventral views.

Text-figure 21.

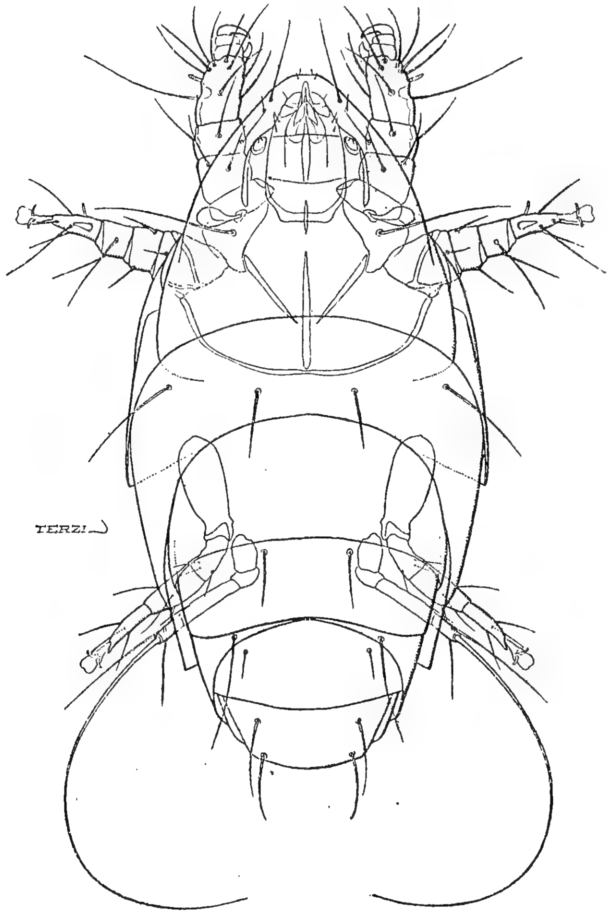


Tarsonemus (*Tarsonemella*) *africanus*, sp. n., ♀. Terminal segments of first leg greatly enlarged.

Pseudotarsonemoides spinitarsus, sp. n. (Text-figs. 22 & 23.)

♀. The usual two little scars (representing accessory stigmata?) are minute and oval in shape, being situated widely apart from one another not far from the lateral margin of the conical anterior prolongation of the cephalothorax. Pseudostigmata

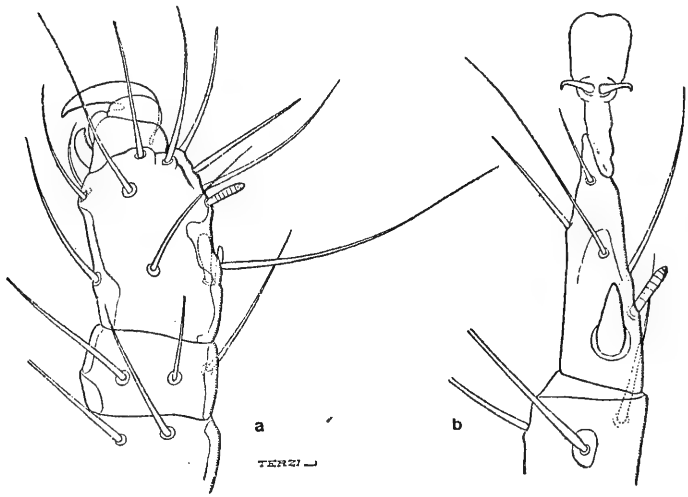
Text-figure 22.



Pseudotarsonemoides spinitarsus, sp. n., ♀.

oval in shape and furnished with very fine short hairs. There is a hair on the dorsum behind the pseudostigma. A transverse row of four fine hairs is present on the dorsal surface of the first abdominal segment. Second abdominal segment apparently without any hairs dorsally. Third abdominal segment with a pair of dorsal hairs. Fourth abdominal segment with two pairs of hairs, the inner ones being much shorter than the outer, exactly as in *P. eccoptogasteris.* The paired lateral epimeral structures lying between the first two legs are not joined to the central linear (longitudinal) chitinous structure (Vitzthum's figure of the ventral surface of *P. eccoptogasteris* shows these lateral epimera joined to the longitudinal central chitinous structure). First leg slightly enlarged; its claw well-developed, but not very large and moving against a short, stout curved spinule. There are a few fine hairs of ordinary type, including a long fine hair near the middle of the dorsal surface, on the first

Text-figure 23.



Pseudotarsonemoides spinitarsus, sp. n., ♀.

a. Terminal segments of first leg.
b. Tarsus of second leg.

tarsus. Three of the hairs are blunt, having the broken-off appearance characteristic of certain hairs also present in Tyroglyphid mites. There also seem to be three sensory setæ (sinneskolben) on the first tarsus; the one nearest the distal end is cylindrical, and projects almost at a right angle to the segment; the other two sensory setæ lie parallel to the tarsus, one of them being stout and club-shaped, the other slender and difficult to see. Tarsus of second leg with a slender sensory seta (sinneskolbe) similar to that present on the first tarsus; there is also *a strong dorso-lateral spinule on the second tarsus* (see text-fig. 23 *b*).

Length of body (including capitulum) 267 μ; its width 135 μ.

Host: The Elm-bark Beetle (*Scolytus destructor*); a single female specimen found on the larva of this beetle at Kew, 19. x. 1922 (*R. C. Fisher*).

NOTE.—This species seems to differ from Vitzthum's *P. eccoptogasteris* in having a stout spinule on the dorsal surface of the second tarsus.

LISTROPHOROIDES, gen. nov.

Body flattened dorso-ventrally instead of laterally, as is the case in the genus *Listrophorus*, etc. All legs with a sucker or pulvillus, that of the first leg being minute and that of the other legs small also. Terminal segments of first and second legs grooved ventrally, the sides of the groove being provided with little knobs and processes for gripping the hair of the host.

LISTROPHOROIDES ÆTHIOPICUS, sp. n. (Text-fig. 24 *a*.)

♂. *Body* moderately elongated. *Capitulum* shaped rather like that of a louse, being roughly triangular but with the lateral angles salient; it is short and wide. *Posterior end* of body in this sex sometimes expanded and almost lobe-shaped as shown in text-fig. 24 *a*; in other specimens the sides of the posterior end of the body are straighter (but this is perhaps due to distortion through shrinkage). There are three pairs of hairs on the posterior end of the body, but they are inconspicuous, two pairs being very short and fine, and the remaining pair not very long, Anal suckers not distinct. Tarsi of anterior *legs* short and modified as described above; the tarsi of the posterior legs are rather long and fairly slender, but the other segments of these limbs are rather stout. Posterior margin of third coxa furnished with two blunt spurs, the inner one being fairly large.

Length (including capitulum) 450 μ; width 187 μ.

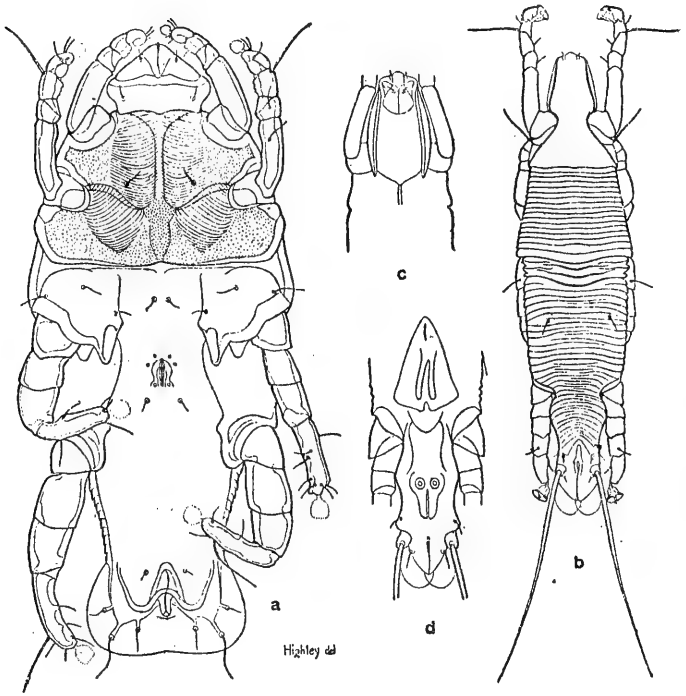
Host: *Cricetomys gambianus*; Accra (*Scott-Macfie Coll.*).

LISTROPHORUS BOTHÆ, sp. n. (Text-fig. 24 *b*, *c*, *d*.)

♂. *Body* narrow and elongated, being about four times as long as wide. *Capitulum* also elongated and rather narrow; its front margin shaped as shown in text-fig. 24 *c*, being only slightly prominent in the middle. Posterior end of abdomen shaped as shown in figure, terminating in a pair of very delicate lobe-shaped laminæ. Just in front of these lobe-like structures there is a more strongly chitinized curved line, which is probably the real posterior margin of the body. A pair of long hairs spring from the posterior end of the body. Anal suckers distinct but small, and rounded in outline. Tarsus of first and second leg furnished with two hairs with blunt ends, one of them being rather long.

♀. Body also elongated as in the male. Unfortunately our female specimens are not well mounted, and therefore cannot be described.

Text-figure 24.



a. Listrophoroides æthiopicus, gen. & sp. n., ♂. Ventral view.
b. Listrophorus bothæ, sp. n., ♂. Dorsal view.
c. Ventral view of anterior extremity of *Listrophorus bothæ*, ♂.
d. Ventral view of posterior extremity of *Listrophorus bothæ*, ♂.

♂. *Length* (including capitulum but not long posterior hairs) 380 μ. Greatest width 93 μ.

♀. *Length* (including capitulum) 430–440 μ.

Host: Gerbille, at Bothaville, Orange Free State (*G. A. H. Bedford*).

Caparinia tripilis Michael.

The presence of a system of tracheal tubes in sarcoptid mites of the genus *Otodectes*, namely in *Otodectes cynotis* var. *cati* and var. *furonis*, has already been pointed out by the author (Journ. Quekett Micr. Club, vol. xiv. 1921, pp. 229 & 230, text-fig. 1). Tracheal tubes also occur in *Caparinia tripilis*, and are very similar in appearance to those present in *Otodectes cynotis*. A parently *Otodectes* and *Caparinia* are the only members of the family Sarcoptidæ possessing a respiratory system of tracheal tubes; but further investigations on this subject are necessary.

48. On the Pelvic Muscles and Generative Organs in the Male Chimpanzee. By Charles F. Sonntag, M.D., F.Z.S., Anatomist to the Society and Demonstrator of Anatomy, University College.

[Received October 1, 1923: Read November 6, 1923.]

(Text-figures 58–64.)

The present paper is intended to fill a gap in the literature on the anatomy of the Chimpanzee, for, although there are descriptions of parts of the male generative organs and the arrangement of the muscles and pelvic viscera, no full account of these parts exists. They have been described fully in the female by Lartschneider (**4**) and myself (**9**). The material on which this account is based consisted of the pelvis of an adult male animal, which lived in the Society's Gardens for nine years, and a young male, about nine years old, which I received soon after it arrived in London.

The Male Generative Organs.

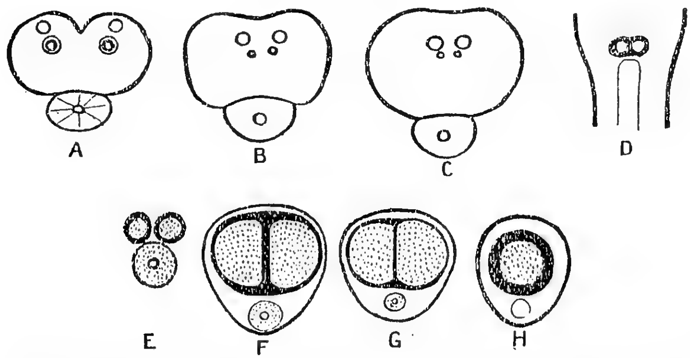
Keith (**2**) states that "The external generative organs are of surprisingly small development; but it must be kept in mind that they have been studied on animals, for the greater part immature, or, if adult, upon animals contracted by long immersion in alcohol." In the two fresh specimens examined by me the penis was certainly small, but the scrotum with its contained testicles was large.

The *penis* is tapering, and it is frequently seen in the erect or semi-erect condition. Duvernoy (**1**) points out that it is often erected when the animal is drinking, particularly if a little wine is added to the fluid. After death the penis may be quite concealed by the prepuce. The anterior extremity has a slight collar-like rim, with a small process underneath. This is the sole representative of the glans penis. In the Orang, according to Milne-Edwards (**6**), there is no rim; and Duvernoy figures an expanded, vertically cleft glans of dark colour in the Gorilla. Kohlbrügge (**3**) figures a globular expansion of the end of the penis in the Gibbons. I also observed a well-marked glans penis. The meatus urinarius is vertical and there is a fossa navicularis. The prepuce is thick in both Chimpanzees and Gibbons.

The corpora cavernosa are cylindrical and of small, but uniform diameter. They are not expanded close to their origins as in Man. They are bound down to the lower borders of the pubic rami, and are covered on three sides by the ischio-cavernosus muscles. The corpus spongiosum has a small bulb attached to the triangular ligament. Its diameter is greater than that of either corpus cavernosum. The corpora cavernosa soon come together. At first they are separated by a thick septum formed from their contiguous walls, but the septum soon thins out and disappears. The dorsum has a groove for vessels and nerves, but the corpus spongiosum is not lodged in a ventral groove. These conditions are seen in text-fig. 58 E–H. In the Orang the conditions are very similar to the above for the septum between the corpora cavernosa soon disappears; and the core of erectile tissue is smaller and the fibrous tunic is relatively thicker than in the Chimpanzee and Man.

The penis contains a small bone, first described by Crisp *. It

Text-figure 58.



Cross-sections through the prostate and urethra (A–C) and through the elements of the penis (E–H). These sections are arranged in order from the base of the prostate to the anterior part of the penis; D: the orifices of the ejaculatory ducts in the urethra.

is a little more than half an inch long, fusiform in shape, with rounded extremities. Crisp figures a rather different shape, whilst Milne-Edwards (6) described and figured the bone as expanded towards one end in the Orang. The penis is fixed to the front of the pubis by two suspensory ligaments, between which vessels and nerves run to the dorsum.

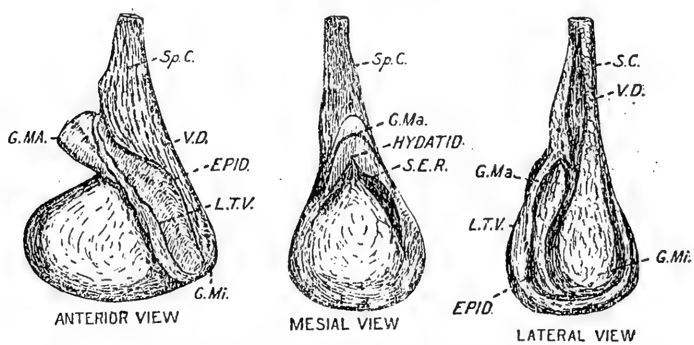
The *scrotum* is capacious, and varies in size from time to time. The skin is darkly pigmented, and has crisp hairs. The median raphé is marked on the surface as a white line, which runs on to the penis. The Gibbon has not got a prominent scrotum, no raphé is present, and the root of the penis lies nearly between the ischial callosities.

The *perineum* is long in the male, but short in the female.

* Proc. Zool. Soc. 1865, p. 48.

The *testicle* (text-figs. 59 and 60) is relatively larger than in Man. In an animal 47 inches long from the crown to the heels, the testis is 2·3 inches long, 1·7 inches wide, and 1 inch thick. The line of attachment of the tunica vaginalis (L.T.V.) runs obliquely across the epididymis (EPID). The upper pole is full and rounded, and a well-marked recess (S.E.R.) lies between it and the overhanging globus major (G.Ma.) of the epididymis. The lower pole is not so massive as the upper pole. The epididymis is a long, narrow body, whose ends are folded inwards towards one another. The flexures constitute the globus major (G.Ma.) and globus minor (G.Mi.). The middle part is straight. On section the testis is seen to have a thick tunica albuginea (T.AL.) with blood-vessels, which are very tortuous. Trabeculæ pass inwards between the tunica albuginea and the corpus Highmorianum (C.H.), which is a large mass of connective tissue with seminal ducts and large blood-vessels. The corpus is relatively

Text-figure 59.



External appearances of the testis. Letters in text.

larger than in Man. The trabeculæ bound well-marked loculi, in which the brownish-yellow seminiferous tubes lie. The trabeculæ also form guides for blood-vessels. The elements of the duct apparatus are as in Man. Thus there appear in succession the seminiferous tubules, vasa recta, rete testis in the corpus Highmorianum, vasa efferentia, coni vasculosi, and the canal of the epididymis. The epididymis is loosely bound to the testis. At the upper pole of the testis a hydatid occurs.

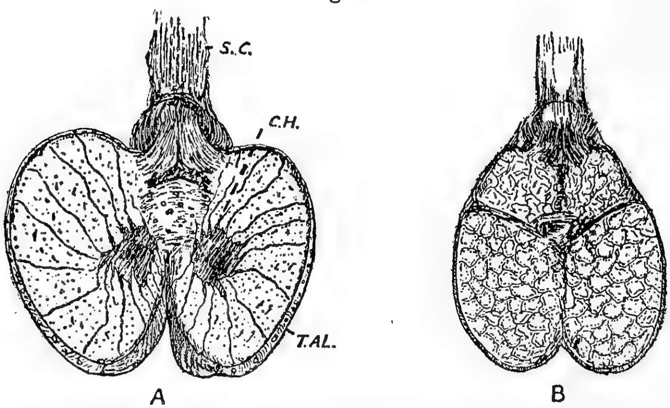
The testis of the Gibbon (text-fig. 60 B) presents a totally different picture from that in the Chimpanzee. A deep fissure divides the organ into two. No corpus Highmorianum is seen, and the surface appears divided by many small sulci into numerous lobules, which are granular. No marked trabeculæ are present in the sulci between the lobules. The internal fissure corresponds to an external fissure.

The sac of the tunica vaginalis is completely shut off from the abdominal cavity in the Chimpanzee and Man. In the Gibbon and Orang the orifice remains open, but a ridge prevents the testis passing to the abdomen in the latter (Milne-Edwards: **6**). The general characters of the testis, particularly the size of the corpus Highmorianum, are identical in the Chimpanzee and Orang. Duvernoy (**1**) points out that the testis of the Gorilla is small relatively to the size of the animal; his illustration shows that the epididymis has the same appearance as, but is relatively larger than in the Chimpanzee.

Retzius (**8**) has made observations on the spermatozoa of the Apes, and finds that those of the Gorilla resemble the human spermatozoa most closely.

The *vas deferens* is gradually formed by a narrowing of the canal of the epididymis; and it has the whip-cord consistence

Text-figure 60.



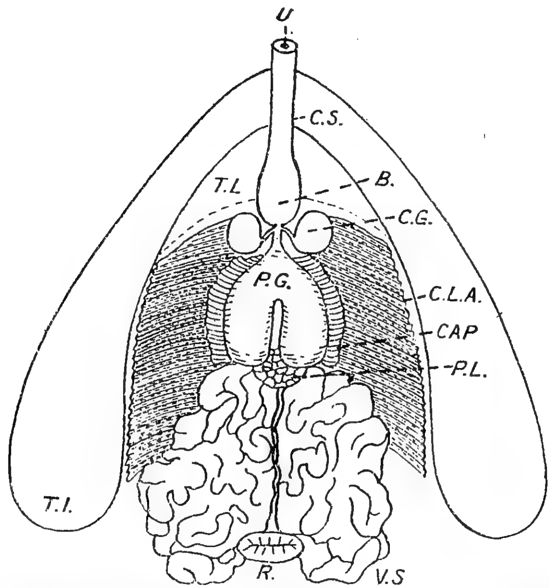
Transverse sections through the testis of the Chimpanzee (A) and Gibbon (B). The halves of the cut testis are folded outwards. Letters in text.

which is usual. It lies in the posterior part of the thick spermatic cord. Its relations in the inguinal canal are as in Man. It runs on the deep surface of the pelvic wall along a line corresponding to the diameter of the acetabular cavity. Then it passes between the bladder and the immense seminal vesicle of its own side. At the level of the middle of the bladder the vasa deferentia come together and run parallel to one another to the prostate. They exhibit fusiform ampullary dilatations; then they narrow and pass into the prostate, where they unite into the common ejaculatory ducts with the ducts of the seminal vesicles. In Man and the Orang they receive the seminal ducts before they enter the prostate.

The *seminal vesicles* (text-fig. 61, V.S.) are two immense, pyriform bodies, whose narrow ends are directed downwards and inwards towards the prostate gland. They conceal the back of the bladder and extend upwards along the rectum (text-fig. 62, R.). Each consists of a long, coiled tube with no saccular dilatations. The same arrangement is present in the Orang and in the Cebidæ, whereas Man has many glands and a short tube. Leuckart (5) pointed out that the length of the tube is inversely proportional to the importance of the diverticula, so the vesiculæ are important secreting organs in Man. The gland has few ducts but an enormous number of lobules in *Mandrillus* (**10**) and some other Cercopithecidæ. The tubes in the Chimpanzee contain milky fluid. Thus the vesicles show the following variations:—

1. Tubes small, lobules numerous—*Homo*, Cercopithecidæ.
2. Tubes long, no lobules—*Simia*, *Anthropopithecus*, *Cebus*.

Text-figure 61.

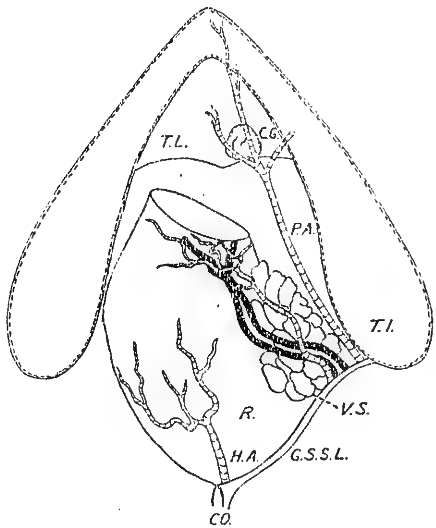


The internal generative organs of the Chimpanzee. B: bulb of urethra; CAP: prostatic capsule laid back; C.L.A: cut edge of levator ani; C.S: corpus spongiosum; T.I: tuber ischii; T.L: triangular ligament; U: urethra. Other letters in text.

The *prostate* (text-fig. 61, P.G.) is of moderate size, and pyramidal in shape with a rounded apex. In a Chimpanzee whose bodily length is 47 inches, the prostate is ·8 inch long and ·55 inch wide across the base. It has a well-marked capsule derived from the pelvic fascia, and its relations to the neighbouring structures in the pelvis are as in Man. A furrow represents a trace of the original division of the gland into two parts, and there is a small pyramidal lobe (P.L.). The tissue is dense. When sections are made through it (text-fig. 58 A–D) it is seen how the urethra is not surrounded by prostatic glandular tissue, but is ante-prostatic; and Milne-Edwards showed how the same arrangement is present in the Orang-Outan. The ducts of the vesiculæ seminales enter the prostate above and lateral to the two vasa deferentia. The vasa and seminal ducts unite to form two tubes, which open side by side into the urethra at the proximal end of a broad ridge (text-fig. 58 D.). The mouths of the ducts are thickened.

Cowper's Glands (text-fig. 61, C.G.):—These glands, which are

Text-figure 62.



The rectum (R.) and its relations to the seminal vesicles (V.S.), hæmorrhoidal artery (H.A.), and pudendal artery (P.A.); CO: coccyx; C.G: Cowper's glands; G.S.S.L: great sciatic ligament; T.I. and T.L. as in text-fig. 61.

the size of large peas, are situated as in Man. Well-marked ducts open into the urethra. The glands are not covered by fibres of the bulbo-cavernosus muscles. They are relatively larger in the Chimpanzee and Orang than in Man. The orifices of the ducts are very minute.

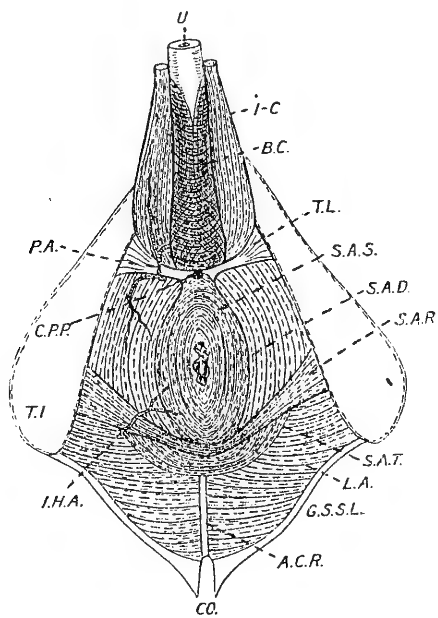
The *bladder* has well-marked lateral ligaments, and the urachus is small, but the anterior ligament is well marked. The anterior wall of the bladder is closely bound down to the pubis below. The mucous membrane is thrown into fine longitudinal folds, quite unlike the greatly corrugated interior which was seen in a female animal.

Muscles of the Perineum and Pelvis (text-figs. 63 and 64).

When the skin is removed from the perineum the subjacent fasciæ are seen to consist of an imperfect superficial fatty stratum and a deep fibrous layer, which is not connected to the triangular ligament.

The *sphincter ani externus* (text-fig. 63) is a powerful muscle, and there is continuity between it and the levator ani. It consists of several parts, most of which form collars round the gut. The superficial part (S.A.S.) arises in front from the triangular

Text-figure 63.



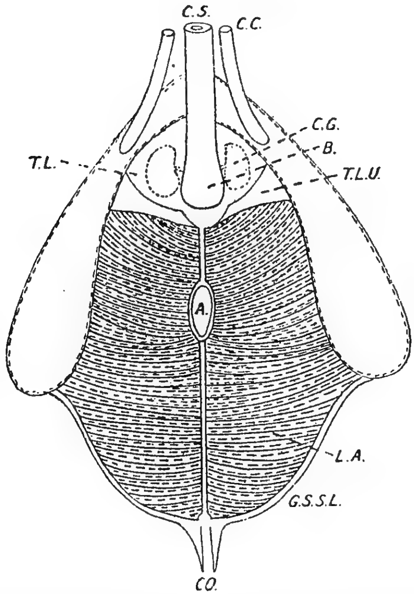
The pelvic muscles. A.C.R.: ano-coccygeal raphé; C.P.P: central point of perineum. Other letters in text.

ligament in the central point of the perineum; they sweep round the anus, but they have no fixed posterior attachment. Two long muscle bands (S.A.R.) arise from the inner aspects of the posterior parts of the ischial tuberosities and meet behind the anus; some of the fibres are continuous with those of the superficial part of the sphincter. The complete band appears like a sling. It is not present in all Chimpanzees, and it may correspond to the retractor ani of lower Mammals. The third part of the muscle (S.A.T.) is composed of fibres arising from the central point of the perineum and sweeping round the gut; it forms a thick collar above and behind the superficial part. The deep part of the muscle (S.A.D.) runs round the gut from the central point of the perineum in front to the ano-coccygeal raphé behind; its deep aspect is in contact with, and receives fibres from, the levator ani.

Transverse Perineal Muscles:—In the two male Chimpanzees, as in the female animal already described by me, there is no trace of the superficial or deep transverse perineal muscles.

The *bulbo-cavernosus* (text-fig. 63, B.C.) arises from the median ventral raphé on the bulb and corpus spongiosum, and the fibres run ventro-dorsally. The posterior fibres completely encircle the bulb, are continuous with the fibres of the opposite muscle, and

Text-figure 64.



The levator ani. C.C: corpus cavernosum; C.S: corpus spongiosum; T.L.U: upwardly curved base of the triangular ligament. Other letters in text.

are inserted into the triangular ligament. The two muscles are separate distal to the bulb, and gradually leave the ventral surface of the corpus spongiosum; they are inserted by small slips into the fascia on the dorsum of the corpora cavernosa.

The *ischio-cavernosus* (text-fig. 63, I-C.) arises from the inner aspect of the lower end of the ischial ramus, the inner aspect of the tuber ischii and the great sacro-sciatic ligament. It is inserted into the under surface of the crus penis and the outer and dorsal aspects of the corpus cavernosum.

When the penile muscles, which are in contact, are removed, the crura, bulb, and *triangular ligament* are exposed. The ligament is strong and composed of two layers, which meet behind and are turned up over the posterior part of the bulbo-cavernosus muscles. The terminal part of the pudendal artery turns up over the recurved base (text-fig. 63, P.A.). The bulb of the corpus spongiosum is attached to the perineal surface of the ligament. When the superficial layer is removed the two large Cowper's glands are seen lying in pockets at the sides of and above the bulb. The glands shine through the superficial part of the ligament.

The *compressor urethræ* encircles the urethra between the layers of the triangular ligament.

Between the anal canal and the obturator internus there lies on each side a narrow, deep ischio-rectal fossa. And the pudendal artery, after emerging from under cover of the great sacro-sciatic ligament, passes along under the fascia at the meeting of the outer and inner walls of the space. The vessel turns up over the triangular ligament and ends by supplying the crura, bulb, Cowper's glands, and the skin of the perineum (text-fig. 63, P.A.). Within the space it gives off the inferior hæmorrhoidal artery to the sphincter and levator ani (text-fig. 63, I.H.A.).

The ischio-rectal fossa has the same boundaries as in Man, and the fasciæ covering its walls are likewise similar. Alcock's canal is, however, poorer.

The *levator ani* (text-figs. 63, 64, L.A.) is covered on both surfaces by fasciæ as in Man. The inferior fascia is delicate and continuous with the equally delicate fascia over the obturator internus. The muscle arises from the back of the body of the pubis, the margin and inner wall of the true pelvis and the place where the ischial spine lies in Man. The fibres pass downwards and inwards to be inserted into the central point of the perineum, the sides of the anal canal, the sphincter ani externus, the ano-coccygeal fascia, and the lower sacral and coccygeal vertebræ. The anterior two-thirds of the muscle are thick and powerful, but the posterior third is thin.

The *coccygeus* has similar attachments and relations to those in Man.

Conclusions.

A. The external generative organs in Man differ from those of the Chimpanzee in the following particulars:—

1. The glans penis is well marked.
2. There is no os penis.
3. The corpus spongiosum lies in a groove on the ventral surface of the fused corpora cavernosa.
4. The septum between the corpora cavernosa persists longer.
5. The connective-tissue walls of the corpora cavernosa are not so thick and they have more erectile tissue.

Man also differs from the Orang in the above features. The chief difference between him and the Gorilla lies in the absence of the os penis.

B. The internal generative organs in Man differ from those in the Chimpanzee in the following respects:—

1. The testis is relatively smaller and the corpus Highmorianum is smaller. The epididymis has a different form.

2. The vesiculæ seminales consist of a short tubular and a large glandular part, whereas the reverse is the case in the Chimpanzee. Moreover, according to Milne-Edwards, the Chimpanzee has the same characters as the Orang.

3. Cowper's glands are relatively smaller.

C. Man and the Chimpanzee agree in the closure of the communication which originally existed between the tunica vaginalis and the peritoneal cavity. In the Orang and Gibbon this remains open.

D. The urethra is ante-prostatic in the Chimpanzee and Orang, whereas it descends through the prostate in Man.

E. The orifices of the ejaculatory ducts are close together in the Chimpanzee, and they appear rounded. In Man they are separated slits. In *Mandrillus* (**10**) there is a common orifice for the two ducts. Milne-Edwards (**6**) points out that the arrangement in the Orang is as described above in the Chimpanzee.

F. The spermatozoa of the Chimpanzee do not resemble those of Man, but those of the Gorilla do according to Retzius (**8**).

G. The interior of the bladder and rectum is as in the female already described by me (**9**).

H. The muscles of the perineum and pelvic floor are built on the same plan as in Man, but the Chimpanzee has a retractor ani and no transverse perineal muscles are present. The ischial spine varies, so there are slight modifications in the origin of the levator ani.

It is, therefore, evident that Man differs in many ways from the Chimpanzee and Orang in the characters of the male reproductive organs. He agrees with the Gorilla in the presence of a glans penis, the characters of the vesiculæ seminales, and in his spermatozoa.

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49. Notes on East African Insects collected 1915–1922.

By Arthur Loveridge, F.E.S., C.M.Z.S.

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It was my intention on returning to England after my first term in East Africa (1915–1919) to publish such field-notes as were of general interest as each order of insects was worked out, over twenty thousand insects having been collected.

The difficulty of getting these determinations performed has, however, prevented the carrying out of my original plan, and as these notes are accumulating, I have made sundry extracts from my journal in the hope that entomologists may find amongst these casual jottings something of interest.

The present miscellany is divided into two parts, (A) being a list of Hymenoptera and their Dipterous mimics taken at Kilosa, and (B) more general observations on Hymenoptera, Coleoptera, Lepidoptera, and Orthoptera. Next year, when more of the material will have been identified, it may be possible to publish a second instalment covering the same and other orders.

Localities may be grouped as follows:—

1. Kenya Colony (late British East Africa).

    Frere Town, on mainland opposite Mombasa Island.
    Mbunyi, north of Taveta and west of Kilimanjaro.
    Nairobi, 327 miles west of Mombasa.
    Ngong, some six miles from Nairobi.

2. Tanganyika Territory (late German East Africa).

    Dutumi, in Morogoro District.
    Handeni, in Pangani District.
    Izikisia, 40 km. N.E. of Tabora in Tabora District.
    Kahe, in Moshi District.
    Kilosa, 80 km. W. of Morogoro in Morogoro District.
    Longido West, *i.e.* west District of Mt. Longido, Arusha.
    Myombo, 75 km. W. of Morogoro in Morogoro District.
    Mkomasi, 30 km. N.W. of Lushoto in Usambara District.
    Morogoro, on Central Railway, ?100 km. west of Dar es Salaam.
    Moshi, on Tanga Railway in Moshi District.
    Ngari Mtoni, six miles west of Arusha, Arusha District.
    Ngeri-ngeri River, south of Ngeri-ngeri Station, Cent. Rly.
    Singida, 120 km. north of Kilamatinde in Dodoma District.
    Tambali, in Tabora District.

3. Portuguese East Africa.

Lumbo is the railhead on mainland 3 miles from Mozambique.

My thanks are due to Professor Poulton for getting most of the identifications made (the work has been particularly difficult owing to rough handling of a store-box in the post, resulting in many of the specimens being badly damaged and in some cases detached from their labels), for proof-reading and his many kindnesses and ready help; to W. C. Crawley, The Rev. F. D. Morice, Dr. J. Waterston (Hymenoptera); Major E. E. Austen, D.S.O., E. Brunetti, F. W. Edwards (Diptera); G. J. Arrow, K. G. Blair (Coleoptera); B. Uvarov (Orthoptera); Dr. F. A. Dixey, Prof. E. B. Poulton, W. H. T. Tams (Lepidoptera); A. S. Hirst (Arachnida), for making the determinations; and to my chief, Mr. C. F. M. Swynnerton, for the interest he has always shown in entomological pursuits, particularly those connected with mimicry and warning coloration.

The material referred to in the following pages is preserved in the Hope Department of the Oxford University Museum, where it may be studied by any naturalist.

A. Hymenoptera and their Dipterous Mimics.

With one exception all the models and mimics mentioned below were taken within an area of 300 square yards on the Otto Plantation, Kilosa, Tanganyika Territory, and with six exceptions (mimics 4, 6, 8, 11, 38, & 40) all were taken on the mosquito gauze protecting the verandahs of one or other of two houses not more than two hundred yards apart and in the same clearing. This rather adds to the interest of the specimens, and it will be understood that unless otherwise stated all the specimens were taken on this gauze.

The actual specimens referred to in the notes were received for every number except, perhaps, No. 34, which is a little uncertain.

1. Xylocopa inconstans Sm., ♀. 31. iii. 21. Only a single example of this Carpenter-bee taken, a very perfect model to (4). The timber of both these houses is infested with the borings of (2) and (3), which I consider form an association in the matter of markings or colour from which (4) is likely to benefit.

2. Xylocopa caffra L., ♀. 13. iv. 22. Very common.

3. Xylocopa nigrita F., ♀. 24. iv. 22. Very common.

4. Hyperechia bifasciata Grünb., ♀ (Laphrinæ: Asilidæ). 13. iv. 22. This Dipterous mimic was taken at 8 a.m. resting in bright sunshine on the verandah-rail just four feet below the nesting-holes of *X. nigrita* F. When approached it flew with a faint buzz to the rain-gutter on the roof and right alongside the nesting-holes: netted.

5. Psammochares sp., probably venans Kohl (Pompilidæ: Fossoria). 6. vi. 21. Very common, as also several similarly-coloured but larger species, which can be seen flying about the paths and open clearings on any sunshiny day.

6. ORECTOCERA DIABOLUS Wied. (Tachinidæ). 17. iv. 22. When walking down a steep path at 1.45 p.m., I noticed this Dipterous insect fly up suddenly—the flight was short and rapid—and, alighting again upon the path, it ran to and fro with jerky movements of the abdomen till it reached a stone, upon which it rested. The movements were almost identical with those of (5) and its allies. The fly must be very scarce here, as I have not met with it before during twelve months' residence at Kilosa.

7. SYNAGRIS CARINATA Sauss., var. ALBONOTATA Beq., ♀ (Eumenidæ: Diploptera). 1. iv. 22. Very common, as are many other similarly-coloured wasps, blue being their common livery as yellow and black is for the vespids at home. *Rhynchium luctuosum* Gerst. is one of these; it also enters into the colour association of No. 5.

8. BROMOPHILA CAFFRA Macq. (Ortalidæ). 9. ii. 21. On a leaf beside the path, almost at the same spot as (6). I do not regard this fly as a direct mimic of (7), but it must derive advantage from adopting the livery of the wasps, which are so common. On 17. iii. 17 I took a number of these flies on flowers and herbage at Morogoro, and noted at the time their slowness of movement. This sluggishness was so pronounced that it was not a difficult matter to catch them by hand *.

9. EUMENES MAXILLOSA de G., ♀ (Eumenidæ). 9. iv. 22.

10. EUMENES DYSCHYROIDES Gribodo, ♀. 29. i. 21.

11. PHYSOCEPHALA sp., ♀ (Conopidæ). 25. iii. 22. I think this is a perfectly wonderful mimic of (9) and (10), but the semi-transparent wings are more like those of other hornets taken here whose abdomens, however, are normal-shaped. This fly was resting on the blossom of a Zinnia at 5.30 p.m., and buzzed loudly when caught by the fingers; it was extremely sluggish. In my diary I have just come across the following note under date 3. v. 17, Morogoro. "Took a fly from a spider's web; it is the very image of the long-waisted wasp. I was deceived by its appearance at first, but the spider was serenely tackling it." Whether this is the same species I cannot say, as the fly was sent home for identification and cannot be traced at the moment. It is either in the Nairobi or British Museum (Nat. Hist.).

12. PSAMMOCHARES sp. A. (Pompilidæ: Fossoria). 1. v. 22. Scarce, at least in the houses; there is a bee here very similarly coloured which I have taken several times.

* The fly ejects yellow liquid from its mouth when handled, and was refused by Dr. G. A. K. Marshall's baboons and *Cercopithecus* (Trans. Ent. Soc. Lond. 1902, p. 531). *Bromophila caffra* is figured by Dr. Marshall on plate xxiii. fig. 27, as one of a S. Rhodesian group of insects with "black bodies, blue wings, and red or yellow heads" (figs. 20–27). See also Dr. G. D. H. Carpenter in Proc. Ent. Soc. 1918, p. c, and Trans. Ent. Soc. 1921, p. 72.

13. NEGRITOMYIA MACULIPENNIS Lw. (Stratiomyidæ). 2. i. 22. This fly was buzzing up and down the white ceiling of a lighted room, when it was approached by an exceptionally large gecko (*Hemidactylus mabouia*), who followed its movements for some time, but hesitated to take it.

13 *a*. 6. iv. 22. Another example with closed wings, showing its close resemblance to the model. During the five months since 2. i. 22 five specimens were taken on the gauze, it being about equally common with the model in this situation. There is a bee here very similarly coloured.

14. APIS MELLIFERA ADANSONI Latr. 22. iii. 22. This bee is a plague, existing in countless thousands in the plantation and often making its combs in the houses (see p. 1019).

15. ERISTALODES QUINQUEMACULATUS F., ♀ (Eristalinæ: Syrphidæ). 2. i. 22. Common but not exactly plentiful; buzzes like the bee both in flight and when caught; it causes quite a pricking of the fingers with its feet when held. On 31. iii. 22 I caught one of these flies and offered it to my monkey (*Cercopithecus albigularis rufilatus*), who would have nothing to do with it though he eyed it closely. I then proffered it to a Fennec Fox (*Octocyon virgatus*), who was watching me and was within two feet of the monkey at the time. He promptly snapped it out of my fingers and crunched it up. I then released the monkey, who went off hunting grasshoppers, and was still busy feeding when I went to bring him in half-an-hour later, so it was not a question of satiety *.

16. MEGACHILE sp., ? UNGULATA Smith, ♀ (Apidæ: Anthophila). 6. vi. 21. A common wild bee. Another bee, *Nomia vulpina* Gerst., would act a as model with (16), as also with (14), and (39); and all four species form together a compound colour association into which still other bees probably enter.

17. SIMOIDES CRASSIPES F., ♀ (Eristalinæ). 21. iii. 22. A mimic of (16).

18. PSAMMOCHARES sp. B. 1. iv. 22. Common.

19 & 19 *a*. PLAGIOSTENOPTERINA SUBMETALLICA Lw. (Stenopterinæ: Ortalidæ). 11. & 15. v. 22. In houses even commoner than the alleged model; when walking slowly up the gauze with closed wings they look very waspish.

20. ICARIA AMBIGUA Gribodo (Vespidæ: Diploptera). 1. iv. 22. This wasp builds small nests on the verandah, where the little colonies of from two to five individuals are quite a common spectacle.

21. ODYNERUS TROPICALIS Sauss., ♀ (Vespidæ). 1. iv. 22. A closely-related species with similar habits.

* Compare Dr. Carpenter's experiments on monkeys with *Eristalis tenax* L. (Trans. Ent. Soc. 1921, pp. 25, 31, 33, 72, 100).

22. Dacus pectoralis Walk. (Trypetidæ). 1. iv. 22. On taking this fly, I went and captured examples of the models from close by. This wonderful mimic is apparently commoner than the model, but not so in reality I believe, the explanation being that on entering the house it immediately flies to the gauze to escape, while the wasps, knowing their way about, make straight for their nests. Accompanying (22) were two other somewhat smaller but very similar species, together with the following.

22 *a*. Dacus brevistylus Bezzi. 21. iii. 22. A smaller species, and possibly forming a protective association with (22).

23. Cerceris sp., ♀ (Sphegidæ : Fossoria). 1. v. 22. Not so common as (20) or (21). The very similar *Icaria distigma* Gerst. was also taken.

24. Dacus sp. nr. lounsburyi Coq., ♀. 13. iv. 22. The only specimen taken.

25. Paniscus opaculus Thoms., very near the British *testaceus* Holmgr. (Ophioninæ : Ichneumonidæ). 2. i. 22. A common ichneumon fly.

26. A species of Pimplinæ (Ichneumonidæ) not in Brit. Mus. 9. iv. 22. By no means abundant.

27. Platyura sp. (Mycetophilidæ). 11. v. 22. The only specimen of this Dipteron I have taken, though I have seen but not captured others.

28. A species of Micropezidæ (Diptera). 2. i. 22. Common.

29. Plecticus elongatus F., ♀ (Stratiomyidæ). 2. i. 22. Very common. It will be observed that the model (25) and Dipterous mimics (28) and (29) were taken on the same day, and not only so but at the same time, on the same gauzed window within a radius of two feet. I have subsequently seen the model and mimic together on several occasions.

29 *a*. Stylogaster sp. (Conopidæ). 11. v. 22. Only a single specimen taken of this very ichneumon-like Dipteron.

30. Pison sp., probably xanthopus Brullé (Sphegidæ : Fossoria). 15. iv. 22. Common.

31. Nomia sp., probably same as unnamed species from Entebbe in Brit. Mus. (Andrenidæ : Anthophila). 27. iii. 22. Common. Another bee of the genus *Halictus* probably enters the same association.

32. Sargus sp. (Stratiomyidæ) and 32 *a*. Probably Sargus sp. 20. iii. 22 & 9. iv. 22. Dipterous mimics of (30) and (31); with closed wings they are very bee-like.

33 and 33*a*. Eumerus sp. (Syrphidæ). 3. i. 22 & 6. i. 22. Bee mimics. (33*a*) has its wings set in the attitude of rest seen in life.

34. Number missing. A large example of No. 31 bears the following date, but it is rather small as a model for (35). 24. i. 22. Bee.

35. Microdon sp. (Syrphidæ). 17. iv. 22. A very bee-like fly when seen walking up the gauze; the illusion is accentuated by the faint buzz it gives when caught.

36. Ischiodon scutellare F., ♀ = Syrphus ægyptius Wied. (Syrphinæ). 1. v. 22. This hover-fly is very like its English relative in appearance, and does not resemble closely any particular wasp which I have taken locally.

37 and 37*a*. Rhynchium sp., prob. radiale Sauss. (Eumenidæ: Diploptera). 20. iii. 22 & 14. i. 22. A common wasp.

38. Ancylorrhynchus Latr. (= Xiphocerus Lw.) sp., ♀ (Dasypogoninæ: Asilidæ). 31. iii. 21. Rare: a pair was taken *in cop.* in the open. A very beautiful general mimic, whose capture recalled exciting moments with my first *Asilus crabroniformis* L. in Cornwall.

39. Megachile pilicrus Mor., ♀ (Apidæ: Anthophila). 7. i. 22. A very common form of bee; there are many species with similar markings, either with the transverse bars similarly coloured or picked out in blue or chrome.

40. Sisyrnodytes sp., prob. new, ♀ (Dasypogoninæ). 26. viii. 21. This is the only specimen of the above series not taken at Kilosa, but at Mkata River some twenty-five miles away. The model or members of the group of models are almost sure to be found at Mkata, where I did practically no collecting. This fly, so far as my memory serves, was captured because it alighted on my coat sleeve.

B. General Observations on Insects.

HYMENOPTERA.

The actual specimens referred to in the following notes on Hymenoptera were only received for Nos. 41 and 49.

41. A species of Bethylidæ, now regarded as Fossorial Hymenoptera (Proc. Ent. Soc. Lond. 1922, p. xxvi). This small Hymenopteron, so ant-like in habit and in the way it runs about, bites (or stings?) most painfully. The usual place to find them was on the back of one's neck inside the collar, where they had probably got by dropping from the thatched roof. Owing to their numbers they constituted quite a pest at Jumbe Mbulu's. (Singida, Dodoma Dist., 11. x. 21.)

42. Chrysididæ. (Actual specimens not available, and it is unsafe to give names of others.) Some Chrysids, four in number, on my window had evidently just emerged from their host cell, for one of their number still had the paper cap of its cell adhering to its feet. (Morogoro, 29. ii. 17.)

43. Xylocopa caffra L. My native collector having left one of these bees in my butterfly net I received a sting. The pain was very sharp but soon subsided, and no swelling resulted. (Morogoro, 10. i. 17.)

44. Xylocopa torrida Westw., ♀. When resting in their holes these bees effectually close the opening of the hole with the dorsal surface of their abdomen pressed closely against it, yet the tip also so placed as to leave the sting operative. As a result I have twice been stung—the first time when leaning against a pole in a hut, and to-day when removing a rubber-tree pole which was infested with these carpenter-bees. I inadvertently placed my hand over one of the entrances, and was promptly stung on the tip of the second finger of the left hand. The pain was intense for a quarter of an hour—fully as bad as that of a scorpion sting. Blue was applied for ten minutes and the pain passed off. By 4 p.m. there was only a stiffness and soreness. The following morning the top section of the finger was much swollen, hard and very tender, and so remained for three days. (Kilosa, 17–20. i. 22.)

45. Melipona braunsi Kohl (Apidæ: Anthophila). This bee, which for my own convenience I have christened "the thirsty bee," was very much in evidence at Lembeni and Dutumi and in certain spots at Morogoro and Kilosa. It settles in crowds upon any exposed surface, such as face and arms, to drink the perspiration. It causes much annoyance by hovering in front of one's eyeballs, and I noticed they congregated on the lower eyelids of the transport mules to drink their tears during the campaign, and caused the animals considerable suffering or at least discomfort. I have often brushed them off as one would a fly without ever receiving a sting. (Morogoro, 24. i. 18.)

46. Apis mellifera adansoni Latr. The East African Wild Honey-Bee is one of the greatest pests in the country. In Nairobi they do not cause much trouble, but in Tanganyika Territory they were a great nuisance during the campaign. The battle of Tanga was a classical instance; in this fight, firing through the trees annoyed the bees, who attacked and routed both combatants *.

My first introduction to the aggressiveness of the insect occurred near Moshi when crossing a clear, fast-flowing stream. With legs crossed on my mule's neck, the water being up to the saddle-flaps, I was almost unseated by the sudden start given by the animal, which ducked her head under water. The next moment something stung me on the back of the hand which for the moment I imagined to be a tsetse, an insect with which I was unacquainted at that time and which we had been told to look out for in the vicinity of these rivers. Glancing down, however, I saw it was a wild bee, clouds of which were coming round us, and many of my companions were already stung. The horses, without requiring any urging, started splashing and galloping

* Von Lettow in his book on this campaign states that the bees were enraged by the firing of his machine-gun company, which had to retire no less than the enemy, and that the widespread rumour that a trap had been laid was entirely fictitious.

through the water and scrambling up a very steep bank. Nearly all the men were waving their helmets wildly about their heads, which was probably a mistake, as most of the stings received proved to be upon the head. I myself received between fifteen and twenty—two of these were on my arms, one on a finger, the rest were about the ears and on the head.

We stampeded for a quarter-of-a-mile before pulling up in answer to the blowing of a whistle—it was a good thing that none of the enemy was about to take advantage of our disorder. As we formed up into squadrons one of the officers rode down the line asking for me, as he knew that I carried a pair of entomological forceps and he wanted a sting removed from just below the eye. One man, who had dropped his helmet and gone back to fetch it, claimed to have a hundred stings; sixty were removed by a friend of his that day, and I took out eleven the following morning. The stings were much more severe than those of an English wasp, and the unpleasant effects lasted from 24 to 48 hours. The person of a hundred stings had the site of each marked with a purple spot. One of mine had a dark clot of blood at the site of puncture, and there was a swelling for six inches around this; the other stings I received caused scarcely any swelling. The nest must have been dependent from one of the branches overhanging the river, and I imagine that someone had brushed against it. (Nr. Moshi, 13. iii. 16.)

At Handeni an Indian was stung to death. The unfortunate man had entered a deserted banda in which was a bee's nest, and the swarm had attacked him; it is surmised that he tripped and fell, for when found he was lying unconscious by the roadside and expired shortly afterwards. I was told that a couple of mules were stung to death near the same spot. When at Morogoro, a monkey was brought to me that had been stung to death by bees. At the time of attack it was chained to a pole, and though several persons made gallant attempts to rescue it they failed. On removing its skin there was scarcely a square inch of its body unmarked by a sting, the surface of the flesh being covered with blood.

A swarm entered my monkey's box, which was fixed on a tall pole; the animal became excited and received two stings, on eyebrow and neck respectively. It was rescued by my boy, who received three stings; three other natives who were passing also got stung. At 5 p.m. a Kavirondo dug out the pole and, balancing it on his shoulder, walked through the camp with it; on nearing the incinerator the bees got excited and, buzzing about his face, caused his nerve at last to give way, so that he dropped both pole and box and fled incontinently. It so happened that the box containing the irate bees fell in the vicinity of the native latrine, and the rapid exit of boys from the place in various states of attire caused much merriment amongst their fellows. A sting which I received upon my cheek took three days to subside. (Morogoro, 9. ii. 18.)

A galvanised iron building in which I took up residence for a time had a cupboard in one corner, in former times the place being used as a cotton-mill. This cupboard had two pipe-like apertures, and seemed to the local bees to be an altogether desirable nesting-site. On 9. i. 17 they swarmed, numbers of them buzzing up and down the window pane by my table. Others persistently buzzed round my nose—not that that organ is in the least flower-like: one of these bees being struck at, stung the offending forearm some three inches above the wrist. The sting was not left behind, and the pain, sharp enough at first, subsided in fifteen minutes; the arm swelled considerably, and this swelling did not entirely disappear till the 13th, *i. e.* four days later.

On January 26th they were again unusually bad. Nearly a thousand must have invaded my quarters during the day; they came like a cloud, and at one time there must have been fully five hundred on the window panes; the noise created reminded one of the room of a wireless operator. I just managed to carry on with my work, though the angry humming of some round nose and mouth was trying to the nerves. On February 5th I killed 747 bees on the window pane by quietly crushing them one by one with a little metal pill-box. One hears of swarms everywhere. Whilst seated writing near the window, I was unexpectedly stung upon the eyelid by a bee which flew in at the window and straight to my eye without any provocation whatever on my part; the poor creature could not extricate its sting, and I had to pull it off forcibly, after it and my eyelid had fluttered up and down for a few seconds. It is very usual for these bees to attack the eyes, and is not a matter of chance.

Another time I noticed some boys pulling a hamali cart in the road outside, when a sudden commotion arose. One native dived beneath the cart and tried to conceal his head beneath his arms, another stripped off his kanzu and tried to wrap his head in it and ran away; the bees were left in the road in possession of the cart, which probably contained some sweet stuff. A similar instance came to my knowledge at Kilosa, where the cart contained goor; the bees held up all the traffic in one of the main roads while they looted the cart.

Twice I dislodged the offenders from the cupboard aforementioned by means of smoke. On a third occasion I was telling a friend of my troubles, when he said "Why do you not clear them out?" I remarked that I had not the necessary materials for making a smoky fire. He made answer: "What do you want with a fire, a stick is all that is necessary?" I fetched him this, and then, seeing that he was in earnest, took refuge inside my mosquito net. The cupboard, I might add, was nine feet high with a floor-space of about four feet square. Presently I heard the stick striking about in the cupboard, and he called out that the bees were all gone, in proof of which he poked out a large piece of comb on the end of the stick. It was perfectly true; he had knocked down the nest in broad daylight, and the bees had fled out of the pipe-hole like a cloud of smoke and he had not received a single sting. He said that to the best of his knowledge he had never been stung in his life, but a few days later this was no longer the case, for he donned a cap in which was one of his homeless bees, and he was stung on the head. Within the next few days he received several more stings.

The bees are dependent on water, and if they get into a room from which there is no escape they soon die. They are very fond of sisal flowers, and clouds may be observed round the tops of the poles when the flowers are in bloom. The blossoms of the rubber-trees are another favourite source of nectar, but the resultant honey which I have tasted is bitter and unpalatable to the European, though the natives devour it readily. A strange thing that I noticed at Morogoro was their liking for commercial rubber. Some boxes of this stood in the sun just outside my quarters, and the heat melted the rubber which leaked out from the damaged boxes; the bees might be seen crawling over this at all hours of the day. Urine also seems to have a great attraction for them. When the rubber blossoms are in bloom the presence of the vast numbers of bees attracted to the plantations causes numbers of Bee-eaters (*Merops apiaster* and *nubicus*) to congregate.

They have few enemies I imagine. When swarming in the office roof numbers of them got into the web of a spider, which after wrapping them up very effectually in silk, cut them loose, so that they were constantly landing on my table. A robber-fly settled on my wife's arm one day with a bee in its grasp; a leg of the bee had got entangled in her sleeve, and some movement caused the insect to fly off; but returning, and failing after several attempts to disentangle its prey, it settled down and sucked the juices *in situ*. (Kilosa, 18.i.22.) A mantis was seen to take one from the window one day, as is mentioned elsewhere.

At Kilosa on 14.ii.21 a comb measuring some six inches in length and three-and-a-half across was formed in the store. This was the work of four days, the swarm being small—a large swarm will make an astonishing quantity of comb in a short time. One swarm, which had been established for fully a week in the office roof and had a huge comb with quantities of honey, suddenly left at 10 a.m. in the morning without any apparent reason; I watched them go, and then examined the comb and found but two bees left.

On 12.ii.22 I recorded that there had been four swarms in the office and three in my store-room during the past month. This swarming generally takes place during the earlier part of the year, synchronising with the greater rains and the abundance of food furnished by the rubber blossoms, which doubtless assists multiplication and the necessity for swarming.

Mr. C. F. M. Swynnerton devised a most effective way of dealing with them. A small quantity of cyanide was crushed and dissolved in hot water and squirted over the swarm with a syringe after dark, with the result that they fell like a shower of rain and only a few individuals would ever recover. For greater effectiveness the swarm would be enclosed as much as possible with matting supported by poles.

47. Belonogaster griseus Fabr. (Vespidæ : Diploptera). These wasps, whose paper nests are to be found pendent from the verandah ceiling of most East African houses, were originally inhabitants of caves, I suppose. One day I came upon a huge overhanging rock—almost a cavern—from whose roof were suspended at least thirty large nests of this species; the half-dozen workers hanging to each assumed threatening attitudes in characteristic fashion at my approach. On my going still nearer, one flew off and stung me on the chin—a thing they rarely do in houses, where they are more used to human beings. The pain was not very bad, though the resultant swelling caused several kind enquiries as to whether I had toothache. (Mt. Longido, 13. ii. 16.)

In climbing a Flamboyant Tree to reach a dove's nest I had the misfortune to disturb the wasps on a nest below me. The first intimation of this was the receiving of a sting on the calf of my leg, six inches below the knee. I drove the wasp off, but in doing so received another sting on my first finger. The sting on the leg was bleeding, and looked as if a piece the size of a pin's head had been bitten out. Putting on my puttees I went off for a four hours' walk, feeling scarcely any inconvenience. On removing the puttees at one o'clock I noticed that the leg had been trying to swell under its wrapping. By 2 p.m. I could scarcely walk, and the limb was very swollen. At 6 p.m. the poisoned leg measured $14\frac{3}{4}$ inches as against the $13\frac{3}{4}$ inches circumference of the other. Next morning it was 15 inches. I had no idea that a wasp's sting could have such bad effects. The finger swelled a little, but this subsided the same day; it was stiff and a little sore on waking the following morning, but had evidently had a much smaller dose of venom. (Morogoro, 15. vi. 17.)

48. Synagris æstuans F., subsp. rufa Stadelmann (Eumenidæ). I came across the nest of this species for the first time to-day. It consisted of two mud-cells, roughly 35×20 mm. in length and breadth. These were side by side on the under surface of a leaf and attached to the mid-rib. The leaf measured 700 mm. in length, but by reason of the weight attached, hung vertically. The lower cell was already sealed; the wasp was resting in the upper one with its head outwards, completely closing the entrance; this was at 4.15 in the afternoon, the weather being dull and cloudy. (Kilosa, 25. iii. 22.)

49. Psammochares venans Kohl, ♀ (Pompilidæ : Fossoria). My wife, who was preceding me down a rough path, suddenly jumped from her cycle and called me to see "such a large spider being stung by a wasp." As I reached the spot the spider was standing on its anterior legs; it might have had six applied to the

ground, but my impression was four, the remainder being in the air and the ventral surface of its abdomen so tilted as to be visible to me standing above. The ventral surface of this spider (*Ctenus* sp., ♀: Clubionidæ) is a very bright scarlet with a black basal patch, ornamented by two very white spots which, I take it, serve as eye-spots. The spider was a female I believe, as I am familiar with the species, having taken one only half the size of this specimen the previous week.

The wasp, which had flown off when first disturbed, had now returned, and was running hither and thither between the stationary cycle wheels looking for the spider; when close to its victim the latter bolted with great swiftness across the road, absolutely abandoning its "warning" or "terrifying attitude." Swift as it was, the wasp was swifter. I could not say if it ran or flew along the surface of the road—probably a combination of both; on overtaking the spider it pounced upon it with the greatest ferocity, curved its abdomen under, and stung vigorously; they rolled over in the road, and as I had nothing but a pen-knife wherewith to capture them, unfortunately they were somewhat damaged. (Kilosa, 28. ii. 22.)

50. Dolichomutilla guineensis Fab., f. aurata Bischoff (Mutillidæ). Rolled in my blankets under a bush, and reading by candle-light, I felt an insect crawling up my leg. Supposing it to be an ant I attempted to brush it off, when I felt a sharp sting, whose effects travelled quickly up my leg to the hip. The pain lasted 48 hours and was like a bad nettle sting, leaving a red and lumpy rash. (Handeni, 25. vi. 16.)

At Morogoro and Kilosa these wingless females were constantly found in the house. At 4.15 p.m. one having crawled up my leg, got caught between my stocking and slipper. It stung me on the upper surface of the foot about $1\frac{1}{2}$ inches behind the little toe. For ten minutes the pain was frantic—far worse than a bee sting. An hour afterwards all pain had disappeared, but treatment had been adopted by placing a small crystal of potassium permanganate on the site of the sting. (Kilosa, 7. vi. 21.)

Heterogyna (Ants).

The actual specimens referred to were only received for Nos. 52 and 53.

51. ? Paltothyreus tarsatus F. or Megaponera fœtens F.

A flight of termites had just taken place after heavy downpours of rain, and the termites were busy discarding their wings, when I noticed one of these ants carrying off a termite; another ant was carrying a spider, whilst a third was laboriously dragging along a stick-insect many times its own bulk. (Longido West, 30. i. 16.)

Passed a dozen or more companies of the large black Ponerine ants which wander across the road in a fusiform body, quite unlike the well-ordered columns of the siafu. Neither do they attack anyone who disturbs them, like the siafu, but, instead, run hither and thither, making a hissing noise not unlike that which a snake might make when rustling away among dead leaves. Perhaps it is an imitation which serves their purpose. (Kerogwe-Handeni Rd., 6. vii. 16.) Later experience of these ants makes me wonder why they were in fusiform formation when I made the note, for generally the hosts are in column formation, unless I am confusing two species.

52. Paltothyreus tarsatus F. I have already described the combat of this species with siafu, and have recorded elsewhere how they attack the eyes of tortoises, causing the poor beasts to die *. Water-tortoises, however, when in their tank readily seize and eat *Paltothyreus*, as did my Fennec Fox (*Otocyon virgatus*) of his own accord when one of these ants emerged from a burrow near him. (Kilosa, 20. ii. 22, 25. ii. 22 & 10. iv. 22.)

I was throwing out some of the peppery seeds of a paupau fruit, when I noticed a sudden activity about the spot where they were falling, and to my surprise saw fully fifteen stink-ants carrying them off. Whether the ants had already been on the spot or had emerged from their holes on scenting the paupau I cannot say. They soon found the paupau in the tortoise enclosure and commenced carrying off the remaining seeds, so they are not wholly carnivorous in their diet. (Kilosa, 15. iv. 22.)

53. Myrmecophiles of Paltothyreus tarsatus. A number of these ants were drying their pupæ and larvæ on the path after heavy rain; on my appearance they started hurrying away, and I was astonished to see scores of *Lepisma*-like insects (probably *Ctenolepisma* sp.) of all ages hurrying after them and running in and out amongst them, also a small beetle (*Onthophagus pugionatus* Boh.: Copridæ) in fewer but considerable numbers followed the ants in company with the *Lepisma*; when touched, these beetles shammed death. Mr. Arrow, who kindly named the *Orthophagus*, said that it was a common species, and suggested that its presence with the ants might be accidental, but there was no doubt about the existence of a true association. (Kilosa, 16. ii. 22.)

54. Cremastogaster castanea Sm., var. tricolor Gerst. A pin with an atom of food on its point was lying on a ledge, when I noticed five of these ants take hold of it and carry it to the edge of the ledge. One ant appeared to be supporting most of the weight, having gripped the pin near the point. I therefore chased off the other four ants and timed the fifth, which supported the whole weight of the pin for fifteen minutes, when I had to leave. (Kilosa, 30. xii. 21.)

These ants, which are a perfect pest in a food cupboard, being fond of meats as well as sweet things, lately started eating

* Proc. Ent. Soc. Lond. 1922, p. xli.

away a cork to get at the raspberry syrup which the bottle contained. It was not a question of eating the surface of the cork which might have been in contact with the syrup, they ate right into the heart of the cork and then downwards. (Kilosa, 15. iv. 22.)

On sitting down to breakfast I noticed one of these ants walking round and round the stem of a vase. I commenced to count how often it did the round, and after 39 times, found it took two minutes to do 29 rounds; at the end of five minutes it seemed to be going as strong as ever, so again timed it, and found it did a little more than 14½ rounds per minute. At the end of ten minutes, as we were timing it again, it began to vary the tour by turning about, and only did 9½ rounds to the minute. It had, however, already done some 150 rounds, and, falling back into its old stride, continued for another five minutes, making in all a quarter-of-an-hour since we began to time it; during this time it had accomplished approximately 200 rounds of a circle 4¼ inches in circumference, giving us an idea of its accomplishments when in column, of 96 yards per hour or more probably 100 yards per hour.

The ant then came down on the table-cloth, but soon returned to the groove and recommenced its absurd parade, which it was still doing when I returned to lunch four hours later. It had, of course, come in on the fresh-cut flowers and was far from home and friends, but why should it exhibit so little intelligence as to wear itself out in this manner? Was it the scent of its own feet that hurried it along, thinking it was on a regular run, or was it the reflection of itself in the highly-polished concave groove that made it fancy it was accompanied by others? I cannot say, but that it was not a foolish individual is proved by the fact that whenever flowers are brought in with this species upon them the same thing happens, sometimes as many as four ants taking part in the procession, frequently going in opposite directions and moving out of each other's way when they meet. (Kilosa, 18. v. 22.)

55. Cardiocondyla emeryi For. An ant which causes a great deal of inconvenience to householders I call the "Sugar-ant" from its fondness for that commodity in particular, and sweet things in general. In my present quarters they swarm on the bed, table, and cupboard and many of them die in the jam; they cross one's paper when writing, and have to be brushed off one's neck, but never retaliate. (Morogoro, 14. xii. 16.)

It is interesting to note that the sugar-ants which formed long columns to and from my cupboard are now absent; only a few individuals are to be seen each day. (Morogoro, 20. iii. 17.)

56. Plagiolepis (Anoplolepis) custodiens Sm. This species is very abundant both at Kilosa and Morogoro, where it will be found running about in incredible numbers on paths and open ground and sometimes swarming on tree-trunks. They attack

any small insect which they can overpower, and to-day I found a small toad (*Bufo regularis*) being actually dragged along by a host of these ants, which so obscured their burden that until I had picked it up and shaken them off I could not tell what it was. These ants cause the natives considerable annoyance by biting their bare legs. (Morogoro, 12. ii. 17.)

57. Œcophylla smaragdina F. This long-legged, somewhat transparent-bodied, yellow ant fastens leaves together to form its nest, and should one brush against the branch bearing the nest, the occupants rush out and stand quivering all over it, whilst others hurry off with open jaws to seek the disturber of their peace and soon cover all the foliage; when they get upon a person they bite savagely, more often on the neck than elsewhere. Their favourite tree is the mango, upon whose fallen fruits they feed; they also eat paupau; I have never seen them carrying insects. They nest in Javanese silk-cotton trees, which bear leaves that seem to be suitable for their purpose. (Kilosa, 21. v. 22.)

58. Dorylus (Anomma), probably nigricans Illig. The siafu, to whom I have referred elsewhere *, have few enemies. One morning I shot one of those timid creatures, an elephant shrew (*Petrodromus nigriseta*), beside a column of ants, which were crossing a bush-path at 6 a.m. To my surprise, on opening the stomach of the shrew, I found it to contain a number of these pests. (Morogoro, 12. vi. 17.)

59. Dorylus helvolus L. On no fewer than three occasions my attention was drawn to amphisbænids (*Monopeltis colobura*), which had been attacked underground by these fierce ants and so tortured that they came to the surface, on one occasion at 2.15 p.m., when the sun beat fiercely upon the scorching sand—conditions which these burrowing lizards detest. This species of ant will attack any freshly-killed body from underneath, but appears to hate the light, and never exposes itself. (Lumbo, 1. ix. 18.)

60. Camponotus (Orthonotomyrmex) sericeus F. One of these greyish ants, which are very common in the house and seem to be much addicted to jam, was carrying a spider along the floor. I picked up another carrying a small chrysid. (Kilosa, 1. xii. 20.)

61. Camponotus sp. I believe it was one of the many species of this genus which disturbed me when lying down beneath a giant tree to sleep, rolled up in my blanket; they invaded me in hundreds and were about half an inch in length. Unfortunately, when turning over, I imprisoned one between my cheek and pillow, and received a severe nip. (Ngeri-ngeri, 24. viii. 16.)

I noticed an ant in my tent to-day which appeared peculiar, and on examination it proved to have the head and thorax of

* Proc. Ent. Soc. Lond. 1922, p. xxxii.

another ant of the same species attached to its antennæ by the jaws of the dead head. Presumably the wearer of this ornament had bitten his comrade in half during some argument. (Morogoro, 30. vi. 17.)

COLEOPTERA.

The actual specimen referred to was only received for No. 65.

62. CICINDELA BREVICOLLIS Wied. A number of these beetles were collected on sandy ground and paths by the river-bank; they harmonized so well with the ground that they were very difficult to see. They were also extremely active, taking to wing on the slightest provocation. (Morogoro, 14. xii. 16.)

63. A tiger-beetle apparently of the same species, flying in front of me, kept settling motionless on the path. I, thinking it was a tsetse, wondered what it was doing there, seeing we were in a cultivated area of some extent, so jumped off my cycle and then saw that it was a beetle. I stalked it, and shot it with a garter! (Kilosa, 1. vii. 21.)

64. ANTHIA STRIATOPUNCTATA Guér., ♂. This large Carabid was seen running acress the arc of light in front of my tent about dusk. In attempting to pick it up, I thrice felt a coolness upon my hand—the fine spraying of a liquid. Just then my boy arrived with a killing-bottle, and as he knelt to seize the beetle, it discharged this secretion full in his eyes, which were at least eighteen inches away, I believe. The pain caused was agonizing, and though bathed immediately, his eyes became very bloodshot and swollen, and so remained for three days, when the discomfort of the protruding eyes had practically subsided, though they were not normal for some time afterwards. The odour was very powerful, flying to the eyes like formalin *. The beetle is quite common in the district. (Izikisia, Tabora Dist., 15. xi. 21.)

65. POPILLIA LIGULATA Ohs., ♂ (Rutelidæ). Among a series of these beetles collected by Salimu during the past week was a Rutelid whose right meso-leg was missing—had never grown. On the opposite side the middle leg had three feet with one base—that is to say, the beetle had five legs on the one side and only two on the other. (Uluguru Mtns., 1. iii. 1921.)

66. MYLABRIS OCULATA var. TRICOLOR Gerst. (Mylabridæ: Heteromera). In my note on the ovipositing of this beetle which was kindly communicated by Prof. Poulton, he drew attention to the typescript being indistinct as regards the fraction of an inch expressing the length of the eggs (Proc. Ent. Soc. Lond. 1921, p. xcii). This should read one-eighth of an inch, and not one-third.

* Compare Dr. Carpenter's experience with *Anthia fornasinii* Bert. (Proc. Ent. Soc. Lond. 1918, p. c) and his experiment on a monkey with *A. striatopunctatæ* (Trans. Ent. Soc. 1921, p. 10); also Dr. Marshall's experiments on monkeys with beetles of this genus (Trans. Ent. Soc. Lond. 1902, pp. 510, 511).

67. Mylabris dicincta Bertol. In this connection I came across a note to the effect that this red-and-black beetle was excavating a burrow on a native path through the mealie crops. (Morogoro, 9. vii. 17.)

68. Mylabris sp. A number of *Mylabris* beetles with scarlet-marked elytra were feeding upon some *Cucumis* plants on May 29th and again to-day. On both occasions there were about eight to each plant and none on the surrounding herbage. The interesting thing about them was the way the males (which were much smaller than the females) followed the females up and down the stem or leaf as the case might be, stroking their elytra and abdomens with their antennæ. Both antennæ of the male would be raised simultaneously, and with these he stroked the female most caressingly. The larger beetle fed unconcernedly or walked about, followed closely by her devoted attendant. (Ngong, Nairobi, 3. vi. 15.)

LEPIDOPTERA.

The specimens referred to were received for Nos. 70, 75, 76, 77, 78, 80, and probably 73, 74, and 79.

One never gets tired of the wonderful butterfly fauna of East Africa; and between Mt. Kenia and Mozambique at one time or another, the writer has seen extraordinary assemblages of them in almost inconceivable numbers and variety, but nothing ever surpassed the display on 17. iii. 16, when they were feasting on the dead transport animals left stranded on the wayside by the tide of war.

On leaving Moshi for Kahe we passed through miles and miles of rubber, coffee, and other plantations. It was a glorious though somewhat steamy day after heavy rain. Never in my life have I seen such thousands of butterflies, all apparently freshly emerged, as they were in the pink of condition. There was one patch of *Papilio demodocus* about eighteen inches in diameter and containing about one hundred closely-packed insects feasting on the intestines of a bullock. On a raw buckskin there was a big crowd of blues, and every puddle in the road was surrounded by numbers of them. (Kahe, 17. iii. 16.)

69. Eurytela hiarbas Drury. Came upon a bush to which a number of Cetoniids were clinging; one of these was on the lower side of a horizontal branch, and immediately above him was the Nymphaline *E. hiarbas*, which was applying its proboscis to a spot of moisture on the twig immediately above the beetle's head; each time it protruded its proboscis to do so, the beetle relaxed its grip with one of its pro-legs and waved it in the direction of the butterfly; replacing the leg, it repeated the action with the opposite leg; the object of this was to drive the butterfly away from the exuding sap. Returning later I found no fewer than three beetle-butterfly groups, and concluded that the

beetles scarify the twigs to obtain the sap, and resented the butterflies partaking of the fruit of their labours. Later in the afternoon a larger Cetoniid was seen in a tree going through the same performance with a *Charaxes*. (Karura Forest, Nairobi, 21. vii. 19.)

70. TERACOLUS CASTA Gerst., ♀ (Pierinæ). Took a butterfly to-day with one pair of wings fully developed; the other pair still in the chrysalis. The butterfly was vainly flapping its fore-wings. (Kilosa, 13. xii. 20.)

71. CATOPSILIA FLORELLA Fabr. (Pierinæ). Besides the migration of this butterfly noticed on 3. v. 15, another migration lasting several days was witnessed in 1919. In both cases the butterflies were going in a north-westerly direction. In the second migration the wind was strongly in their favour, but if I recollect aright, adverse on one somewhat cold day *. (Nairobi, v. 19.)

72. PAPILIO DEMODOCUS Esper. Watched this Swallowtail curving its abdomen under the leaves of a lime-tree for purposes of oviposition. It did not seem easily satisfied in the selection of a leaf, and the eggs were laid singly. (Kilosa, 28. xi. 20.)

Took a very young larva which has a wonderful resemblance to a bird-dropping. (Kilosa, 29. xi. 20.)

Very common *in cop.* just now. (Kilosa, 18. xii. 20.)

From later observations I have come to the conclusion that the species breeds all the year round, though principally in the rains. Larvæ were taken at Durban on 21. xii. 14.

73. NEPHELE PENEUS PENEUS Cram. When the rubber-trees are in bloom hundreds of these hawk-moths are to be seen flashing about the tree-tops, where they are difficult to obtain. Later in the season they come to the paupau flowers, and the only way to net them is by cutting off all the leaves of the paupau-tree. They are not nocturnal, strictly speaking, but crepuscular, becoming active again about 5 a.m. (Kilosa, 31. v. 22.) Flying with them was the much rarer *Nephele bipartita* Butl.

74. ACTIAS MIMOSÆ Boisd. (Saturniidæ). Discovered the cocoon of a Queen Moth, which is one of the prettiest things in the way of cocoons. It was spun on the lichen-covered twigs of a fir-like tree. It is of a very silvery appearance, and if a section be cut out, the texture will be found so strong that it is impossible to tear. There are small breathing-holes at the top end, just beneath the opening from which the moth emerges. At the lower end are a few more holes, possibly for the sake of a current of air or to carry off any moisture. (Makindu, 31. vii. 16.)

* Compare the records of migration of this species in Proc. Ent. Soc. Lond. 1921, p. xxiii.

Of four live cocoons received yesterday from Natal a male emerged at 2 p.m. this afternoon. By 3 p.m. it seemed to have finished developing the wings, whose monstrous tails are 3 inches in length. At 4 p.m. it opened the wings and rested with them flat—the resting moth had a most striking appearance. (Nairobi, 23. viii. 19.)

At 9 p.m. I heard a crackling noise from one of the remaining cocoons, from which I had cut a small section the better to observe the pupa within. The latter was swollen, making the abdominal rings very noticeable. I watched the moth climb from the funnel and withdraw its abdomen very suddenly; after recovering from its exhaustion, it adjusted its position on the outside of the cocoon. With the exception of the mauve costa, the wings appeared to be entirely orange-yellow at this stage; a pale green blush began to suffuse the wings, commencing at their basal parts. The green spread and deepened in tone until it had replaced the greater part of the yellow. On emergence the tails were very short—a quarter of an inch perhaps—and were the last part of the wings to develop. At 11.45 p.m. I was awakened by the moth flying round the room, and on turning up the light found a second specimen had emerged and was nearly dry. Both were males. (Nairobi, 27. viii. 19.)

75. Rhodogastria vitrea Plotz (Arctiinæ). When walking up the path at 4 p.m. I disturbed a hunting party of the Helmeted Shrikes (*Prionops talacoma*), which flew into a large tree overhead and recommenced their researches there. Immediately afterwards a fine moth in emerged condition dropped down on the path, almost at my feet. I poked it with a twig, but, as it did not move but shammed death, tried to pick it up by one of its vivid red legs, whereupon it began to exude a bright yellow fluid from both "shoulders," this fluid coming out as a froth with a marked rotary motion. I passed the twig beneath the moth, hoping it would clamber up it; to my surprise it seized the twig with its hind-legs only, and, as I raised the stick in the air, it picked up two lumps of quartz from the path, the larger lump measuring $10 \times 15 \times 6$ mm. As I carried the moth along with me, it carried the quartz for fully a minute before dropping it, and for yet another minute it remained supporting its own weight by its hind-legs. The pillars of froth stood up well from its shoulders, being about 3 mm. in diameter and 8 or 10 mm. long. Suddenly the froth dissolved into drops, which fell upon my hand, and the moth with rapid darting flight made off. The fluid smelt to me like the secretions of the cloacal glands of a British Grass-snake, which is also used as a defence *. (Kilosa, 8. vi. 21.)

* Dr. Carpenter has observed the same method of defence in an allied species, *R. leucoptera* Hmpsn., and has recorded the acrid odour and taste of the secretion (Proc. Ent. Soc. Lond. 1913, p. xcvii).

76. MAXERA MARCHALI Boisd. (Ophiderinæ : Noctuidæ). Whilst in the garden my wife's attention was drawn to something moving amongst the dead leaves. A rolled-up leaf 19×8 mm. was making progress by a series of little jumps. Placed on a tablecloth, it journeyed first in one direction and then in another quite aimlessly. On opening the leaf a flattish moth larva was found. (Kilosa ,12. iv. 22.)

On opening the leaf I found the maggot-like larva had pupated. (Kilosa, 24. iv. 22.)

On going to the box in which I had placed the chrysalis, I was sorry to find the small brown moth had emerged some time, as it was already dry; the time taken for development was thus extremely short. (Kilosa, 5. v. 22.)

77. ANAPHE RETICULATA Walk. (Notodontidæ). Last November I found the cocoon of a wild gregarious silk-moth. The cocoon is a khaki-coloured, strongly-woven structure 190 mm. ($7\frac{1}{2}$ inches) in length and 110 mm. ($4\frac{1}{4}$ inches) in diameter at the broadest part. Through its axis passes a branch of the food-plant, whose twigs and leaves are incorporated with the mass of silk. At the upper end are two chimneys or funnels protruding 20 mm. ($\frac{3}{4}$ in.) from the surface of the pear-shaped cocoon. Through these the moths emerge at dusk and for two hours afterwards. I never recollect seeing any emerge after 9 p.m., though doubtless they occasionally do so.

The business-like hurry with which the moths emerge, as if accustomed to do so all their lives, is quite amusing. The head of each moth as it emerges is protected by a little helmet of shamrock-shape, each of whose "leaves" is deeply concave. This helmet is, of course, part of the head-piece of the chrysalis, and serves to protect the eyes and delicate head of the moth as it pushes its way out of the funnel. As soon as the head was clear of the funnel, up went a pro-leg and gave a push to the mask, which fell to the ground; quite a heap of these were found each morning almost immediately beneath the funnels.

Moving hurriedly and crabwise the insect then travels from the funnel to the under side of the cocoon, where it hangs whilst its crumpled and draggled wings open out, develop, and take shape, the brown lines on the creamy ground becoming clearly defined. The wings were then raised above the back in the position of those of a butterfly; from time to time they were shivered, apparently to test their muscles. After hardening, they are brought to the usual position of a moth at rest, lying one across the other upon the back, forming approximately a triangle. If disturbed at all the moth discharges a pinkish excretion, and this fluid leaves with such force that I should think it carries a distance of quite nine inches from the moth.

Theoretically this is the middle of the rainy season, but there have been no rains recently; nevertheless three of the moths emerged this evening. I will give the rest of the dates of emergence serially, with the numbers of moths which emerged from the cocoon each day. (Morogoro, 18. iii. 18): —

March 19th	9	March 25th	40
,, 20th	13	,, 26th	56
,, 21st	10	,, 27th	22
,, 22nd	13	,, 28th	9
,, 23rd	16	,, 29th	10
,, 24th	25	,, 30th	4

After this not more than ones or twos emerged at long intervals and often crippled, the total not exceeding ten. If we assume there were ten, it gives the astonishing total of 240 moths emerging from this one cocoon. (Morogoro, 30. iii. 18.)

Found a second cocoon on a small shrub and, assuming the moths had emerged, put it away in a trunk. (Kilosa, 30. xii. 20.) On opening the trunk I found some 14 or 16 had recently emerged. (Kilosa, 10. iii. 21.) From this date the following emergences took place: —

March 11th	4	March 17th	1
,, 12th	2	,, 18th	2
,, 13th	2	,, 19th	nil
,, 14th	2	,, 20th	1
,, 15th	2	,, 24th	1

This cocoon therefore only produced one-seventh the number of the former, which was quite twice its size. The total number emerging was 32. (Kilosa, 24. iii. 21.)

Thinking a record of the incidence of sex among those that emerged would be more interesting than the bare totals, on receiving a nest from the Tabora District brought back by one of my native collectors, the results were tabulated as follows: —

December 26th	2,	♂ ♀
,, 27th	5,	♂ ♂ ♂ ♀ & ?
,, 28th	3,	♂ ♂ ♀
,, 29th	2,	♂ & ?
January 9th	1,	♀
,, 10th	8,	♂ ♂ ♂ ♂ ♂ ♂ ♀ ♀
,, 11th	12,	♂ ♂ ♂ ♂ ♂ ♀ ♀ ♀ ♀ ♀ ♀ ♀
,, 12th	7,	♂ ♀ ♀ ♀ ♀ ♀ ♀
,, 13th	2,	♀ ♀
,, 14th	1,	♀
,, 17th	3,	♀ ♀ ♀ (one was a cripple)
,, 18th	1,	♀
,, 19th	1,	♀

Total emerged 47, composed of 2 not sexed, 19 males, and 27 females. As one would expect, males preponderate in the first days of emerging and females very markedly towards the end. There is a curious gap between December 29th and January 9th, when none emerged; this was not to be accounted for by the weather, which was almost uniformly hot and dry throughout, though I believe one or two showers did occur. (Kilosa, 19. i. 22.)

78. An AMYDRIA and another Tineid too worn to be identified; also *Ephestia cautella* Walk. (Phycitinæ: Pyralidæ). Writing from an ex-enemy cotton warehouse where I was camped for a few days:—"There are some hundreds of clothes-moths hatching out in this building every day, presumably having bred in the large stock of cotton which the Germans have housed here for two years past. I was very interested in seeing a dozen males assembling on the outside of my mosquito net and moving to and fro in ceaseless agitation over a square inch of net—not till then did I notice the female on the inside of the net. Killed the males. Next morning there were some more, so I killed the female and drove off the males, but they returned to the spot and continued to move over it for probably half-an-hour after she had gone." (Morogoro, 19. iii. 17.)

79. DREATA (JANA) sp. (Eupterotidæ). The large and hairy caterpillars of this moth are from three to four inches long, and their clothing of fine hair over an inch in length makes them look inviting to stroke. The white or greyish hair, however, conceals sharp rufous-coloured spines arranged around the body segments. If you attempt to pick up this caterpillar the spines are driven into your flesh, where they remain, being very brittle. Fortunately they are not barbed, so they can be drawn out, though it is difficult to do so as they snap on account of the afore-mentioned brittleness. In endeavouring to pick up one of these larvæ to-day I utilized a leaf of a rubber-tree to protect my fingers, and was astonished to find the spines driven through the leaf and into my finger. Unless poison was removed in passing through the leaf, I do not think they are poisonous, as only mechanical irritation was felt. The leaf bristled with them, and a piece of paper proved to be no better protection. When interfered with, the caterpillar half curves its body, which has the effect of bringing the spines into prominence and making them more rigid, I think. (Kilosa, 25. iii. 22.)

One of the caterpillars cast its skin yesterday and the other to-day, though collected independently. (Kilosa, 7. iv. 22.)

80. PROCESSIONARY CATERPILLARS. I came across a proper caterpillar procession for the first time to-day. A clump of the caterpillars, owing to their long, wavy, white hair which almost obscured their dark green skins, had the appearance of a large luxuriant patch of American blight. The clump was about four feet from the ground on the bark of a tree, and reaching to the ground was a single line of caterpillars; another line led up from the clump. Each member of the procession had its head closely applied to the "tail" of its predecessor, and they moved forward

very slowly, after the fashion of London taxicabs closing up in a press. The caterpillars were $1\frac{1}{2}$ inches in length. (Handeni, 27. vi. 16.)

Some six miles from Kilosa along the railway line for Kigoma is Jumbe Sunguru's village. Here close to the line is a mighty wild fig-tree, big as an English elm, and as I was passing it to-day I saw that every bit of this great tree as far as its topmost twigs was smothered in grey hairy caterpillars, each bearing on its back two spots—tufts of black hairs in reality. The caterpillars seemed to be moving slowly up the tree with long silken threads in great profusion as if to guide them, and as I walked around the tree surveying this wonderful sight from different points, I came upon a small column travelling with haste across the path. Following this line back, I found they were descending from a smaller tree—no larger than a crab-apple, and of much the same appearance—which still had plenty of leaves, so why they should leave a land of plenty and go on this pilgrimage to a tree already much depleted of foliage and overstocked with caterpillars, I could not understand.

I could not see the caterpillars feeding on the leaves, but a gentle rain of droppings kept falling, and the surrounding ground was already well-covered, whilst unsightly masses of web and silken thread loaded with excrement depended from the larger branches. It was difficult to see what the main body on the bole of the tree would get to eat to-day, but for the time being they had something else to distract their attention. Several minute black ichneumon flies were hovering over them, and when one of these approached a caterpillar, the latter would jerk its head and forepart of the body most violently backwards, and the little fly would move off. How it could get close enough to oviposit an egg in the skin of such a hairy caterpillar was the problem confronting the insect, but doubtless it would eventually succeed in doing so. (Kilosa, 30. vi. 21.)

On August 6th I revisited the tree and collected four pupæ which were concealed beneath a mat of webbing. Two were of one species and two of another.

Two pupæ were green, but the shells left after emergence were transparent and colourless except for their bright red "tails." They produced ochre-coloured moths with a reddish spot on each fore-wing—*Nygmia crocosticta* Hmpsn., or a race of this species, being smaller and more richly coloured than the type which came from the west of Lake Nyasa. (Kilosa, 14. viii. 21.) These moths are Liparidæ (Lymantridæ), a family not known to include processionary larvæ. They may have accidentally pupated in the web of the true processionaries or were perhaps definitely associated with them.

The two other pupæ were brown with four longitudinal series of golden-brown spots. They were 17 mm. in length over all, except the terminal spine which was a millimetre long. One moth either failed to emerge or was lost. The pupa of the other was submitted to Mr. Tams who found that it contained a parasitic pupa which Dr. Waterston identifies as a species of *Brachymeria* (= *Chalcis* auct.). An anterior prominence on the moth pupa resembles that found in the Notodontid genus *Thaumetopœa*, known to have processional larvæ. The species may have been *T. apologetica* Strand, from East Africa, or an allied form.

ORTHOPTERA.

The specimens referred to were received for Nos. 83, 85, 86, 89, 91, 92, 93, 94 *a*, 95, and 98.

81. ORTHOPTERA have many enemies. In the stomach of a Mungoose (*Mungos mungo colonus*) shot to-day were cockroaches, locusts, grasshoppers, and a number of other insects. (Morogoro, 11. xi. 17.)

A Kestrel's (*Cerchneis tinnunculus*) stomach contents showed it to have been feeding chiefly on locusts. (Morogoro, 4. xii. 17.)

A Cattle Egret (*Bubulcus ibis*) had a great number of grasshoppers in its stomach. (Morogoro, 14. xii. 17.)

GRYLLIDÆ.

82. BRACHYTRYPES MEMBRANACEUS Dru. My first acquaintance with this huge cricket was at Morogoro, where an officer of the Flying Corps brought me a specimen 2½ inches long and ¾ broad at the widest part; he rather aptly compared its song to the hum of a gnome engine. (Morogoro, 3. v. 17.)

One of these crickets was shrilling away beneath a shrub two nights ago: my boy located it, but it dived down its hole; he made a big excavation, but missed it; last night presumably the same cricket was under the next bush twenty feet away. To-night it was at the back of the house a hundred feet from its last location. I went to see it, and found it was just beginning a burrow into which it dived, but was easily dug out. It had a single egg in the oviduct, not round but slightly pointed at each end. (Kilosa, 12. iv. 22.)

Again, to-night I found a cricket shrilling outside its burrow, and was able to approach within a foot of it with an acetylene lamp, and stand some time before it made off. It also was a female with an egg ready for oviposition. Within a few inches of it was a gecko (*Hemidactylus squamulatus*) perfectly motionless as if dazed by, or enjoying, the noise. (Kilosa, 13. iv. 22.)

Each morning one sees little heaps of excavated sand about the camp, and near them are tracks, not unlike those of a rat at first glance, which show the extent of the insect's nocturnal peregrinations. At dawn, and for about an hour afterwards, it is not uncommon to find stragglers still above ground. If dug out they are usually not more than a foot below the surface. Lately I have been feeding the small Mungoose (*Helogale ivori*) upon them, as they show much eagerness for this form of diet, snapping them from one's fingers.

83. Liogryllus bimaculatus de Geer. This species is very widely distributed throughout East Africa. At Mkomasi I discovered two crickets beneath an old battered biscuit tin; one was already dead and dismembered, the other in the jaws of a scorpion (*Odonturus dentatus* Karsch), which was busily engaged sucking its juices. As I was pulling the cricket away from the scorpion a Sand-snake's head was protruded from the tin. (Mkomasi, 2. vi. 16.)

Tettigoniidæ = Locustidæ.

84. Enyaliopsis sp. I caught two of the wingless long-horned grasshoppers which are very common here. I woke up with one on my face the other night, and several of my comrades have found them in their blankets. (Dutumi, 20. ix. 16.)

85. Larva of a species of Gryllacrinæ. On my table for a week past has been lying a newspaper cutting—a portrait. This morning I found it mutilated in circular fashion as might have been done by a rose-cutter bee. The cut-out portion had been turned up flap-wise and carefully cemented down to form a little cell without entrance; neither was there any trace of cement or silk. Opening this I found within it a pink larva. (Lumbo, 25. ix. 18.)

86. Clonia wahlbergi Stål. A native brought me a specimen of this peculiar insect, the like of which I had never seen before. (Morogoro, 11. i. 17.) Two were subsequently taken at Kilosa, where they had apparently come to light. (Kilosa, 18. xii. 20 and 18. i. 21.)

87. Pseudorhynchus pungens Schaum. Heavy rainfall last night and to-day; the countryside is teeming with these Orthoptera. They were just as thick as locusts, in a rubber plantation near here. One had to shield the eyes to protect them from the storm of insects which flew against one's face and body. The brown forms were greatly in the minority, being about 5 per cent. They showed no selection in choosing sites, as they settled on bright green rubber-leaves just as readily as in the dry brown grass. (Kilosa, 1. xi. 20.)

The insects are plentiful here also—*i. e.*, some six miles from Kilosa. (Miombo, 4. xi. 20.)

Acrididæ.

88. Lamarckiana sp. I put one of these cryptically-coloured grasshoppers into a tin as food for a large Mygale spider (*Pterinochilus* sp.: Avicularidæ), but on opening the tin found that the grasshopper had killed the spider by biting its abdomen. (Nr. Moshi, 17. iii. 16.)

89. SCHISTOCERA GREGARIA Forsk. Locusts of this species travelling in a S.S.W. direction have literally peppered the sky to-day, but vagaries in the wind have caused many of them to settle. (Morogoro, 11. xii. 16.)

The most striking thing about the insect-life to-day were the locusts of two species (the second being *Zonocerus elegans*) which were simply swarming everywhere; the herbage was literally alive with the stragglers of the swarm of yellow adults that passed over here three days ago. I met a native woman putting them into a pail for dinner. On the middens outside the huts are great piles of wings and hind-legs, the relics of recent feasting. (Morogoro, 14. xii. 16.)

90. ZONOCERUS ELEGANS Thunb. A rather surprising situation for immature grasshoppers of gaudy colour were the holes caused by the larvæ of many species of longicorn in the thorn-trees, whose timber was almost as hard to cut as stone. Yet I took many of these young grasshoppers as high up as seven feet, and might have found them still higher had I chopped further up the stems. Immediately their hiding places were laid open they sprang into the air. (Mbunyi, 17. v. 16.)

This species is very interesting on account of the small proportion that develop wings. The insects frequently mate while their wings are quite rudimentary. The development of the wings is, I take it, a matter of no importance to the owner's safety, which is guaranteed to a great extent by its gaudy, aposematic colouring and offensive smell. (Morogoro, 14. xii. 16.)

These grasshoppers, apparently so warningly-coloured, are eaten with avidity by hungry lizards (*Gerrhosaurus major*) and somewhat reluctantly by a Chameleon (*C. dilepis dilepis*)*. (Morogoro, 22. x. 17.)

This species comprised part of the stomach contents of a Crested Cuckoo (*Coccystes glandarius*). (Morogoro, 29. i. 18.)

Also found in the stomach of another species of Cuckoo (*Coccystes jacobinus*). (Morogoro, 29. xi. 18.)

91. PHYMATEUS VIRIDIPES Stål. Captured three large *Phymateus* insects of the usual vivid green colour with scarlet, blue, and green under-wings; there were four of them on the bush, nevertheless I did not notice them till the first moved. A curious mixture of protective and aposematic colouring, they are rather slow in their movements and only take short flights, relying for safety on the frothy bubbles discharged from glands situated just behind the large jumping-legs. (Ngari Mtoni, near Arusha, 4. iv. 16.)

Took a pair of these Acridians at Morogoro, where they are far from common. (Morogoro, 10. i. 17.)

92. CYSTOCŒLIA ABSIDATA Karsch. Just by my tent someone caught a very queer orthopteron. Its length over all is $4\frac{3}{4}$ inches;

* Compare Dr. Carpenter's experiments on monkeys with this Acridian (Trans. Ent. Soc. 1921, pp. 8, 33, 53, 98).

$2\frac{1}{8}$ of this is occupied by the abdomen. A casque of $2\frac{3}{8}$ inches protects the head and well-developed wings. In breadth the casque is $1\frac{1}{2}$ inches, in height $1\frac{3}{4}$ inches, and looks out of all proportion to the rest of the insect.

The colour of the creature is a pale green with mid-ribs and venations of the casque in yellow; the vein-like ribs are punctuated at intervals by yellow spots. Two peculiar silver blotches occur about half-way along the casque, one on each side; these can be seen from above. The upper wings have each a bright splash of ultramarine near their junction with the body. (Morogoro, 14. v. 17.)

PHASMIDÆ.

93. PALOPHUS GREYI Grand., ♂. A native brought me a fine stick-insect measuring $11\frac{7}{8}$ inches in length; antennæ $4\frac{7}{8}$ inches; hind-legs $4\frac{3}{4}$ inches; opened wing $3\frac{7}{8}$ inches; elytra $\frac{3}{4}$ inch long, each having a hollow excrescence resembling a thorn. Large stick-insects are rare in East Africa; I have only come across two during three years, and these were of different species. (Morogoro, 1. ii. 18.)

MANTIDÆ.

94. PRAYING MANTIDS non det. An egg-mass of a mantis, which I collected a month ago has just hatched out and given rise to a few score grotesque little black mantids. (Morogoro, 20. iii. 17.)

In the stomach of a Hornbill (*Lophoceros deckeni*) were two large and complete mantids. (Morogoro, 1. vi. 17.)

A Hornbill (*Lophoceros naumanni*) which was mobbed by some small birds had a large mantis in its stomach. (Morogoro, 15. vi. 17.)

94 *a*. DACTYLOPTERYX sp. not in Brit. Mus. Took a mantis which gave me a great deal of trouble to capture. It harmonized most perfectly with the bark of the tree on which I found it, and ran round the tree and up and down with the agility of a gecko. (Morogoro, 2. ii. 17.)

95. POLYSPILOTA ÆRUGINOSA Goeze. Whilst at my meals all sort of trifles such as moth or fly wings come floating down. This is a sign that a praying mantis is also dining. He took up residence near the ventilating holes at the apex of my bell-tent, and is between the two covers. Apparently he finds it a good spot, for he has been there a very long time. (Morogoro, 15. vi. 17.)

One of the Black-headed Weavers (*Ploceus nigriceps*) surprised me to-day by dodging after a mantis in the fashion of a flycatcher. Almost immediately after catching it, however, it dropped it again, presumably owing to the mantis making good use of its toothed fore-legs and perhaps jaws. (Morogoro, 7. xii. 17.)

A specimen of this green mantis was brought me at 6 p.m., having been found on a tree-trunk. It deposited an egg-mass, $1\frac{1}{2}$ inches in length and 1 inch in diameter, on the window frame before 8 a.m. It stayed beside the eggs till dusk the following evening, when it disappeared. (Nairobi, 7. viii. 19.)

The boy brought me two more specimens of this mantis—one immature but almost fully-grown and an adult. The latter measured in head and body 68 mm., abdomen only 45 mm. In its abdominal cavity, and quite free, I found a Gordian Worm (*Gordius* sp., Baylis det.) 378 mm. in length and 1·5 mm. in diameter. It would be interesting to calculate what length of worm a human could carry in proportionate body-weights if he were afflicted with such pests. (Nairobi, 12. viii. 19.)

96. Sphodromantis viridis Forsk. Four or five days ago I brought a gravid mantis into the house; it spent most of its time resting on a vase of flowers near the mosquito-gauzed window. This morning a male mantis was on the gauze six inches from the female. I therefore went outside and brought him in at 9 a.m. The female was clinging to the gauze head upwards, about 9 inches below the male, who was head downwards. At 12.17 p.m. the female took two short steps in the direction of the male. At 12.19 p.m. with a rapid jump he sprang upon her, his head being towards her tail; he turned so quickly that his fore-legs grasped her just anterior to the middle pair of legs and base of wings. His second pair of legs rested on her wings, also his left posterior leg, the right posterior leg being in space. The terminal segment of his abdomen was twisted round in a quite impossible way to form the union. They remained paired thus from 12.19 p.m. to sundown at 6 p.m. (29. iv. 21). They paired again for a couple of hours at noon, but after this made no further attempts (30. iv. 21). Eggs were laid on the window gauze (24. v. 21). Eggs hatched; young sloughed shortly after hatching. They are greyish-fawn in colour, with legs striped like those of a *Stegomyia fasciata*, but not in such contrasting black and white. (Kilosa, 6. vii. 21.)

97. Omomantis zebrata Charp. A mantis, being put upon a mosquito-meshed window where there were three bees, carefully stalked them, swaying backwards and forwards with every step just like a chameleon. It is curious to note that two creatures so entirely different except in their green colour should have developed precisely the same gait, which to my mind is meant to simulate the movements of a leaf swaying gently to and fro in a breeze, and enables them to approach within striking distance of their prey—the one with its tongue, the other with its specially modified pro-legs. The mantis seized the bee with these; the abdomen of the bee was held as in a vice in the left, its head in the right; without loss of time the mantis bit into and crunched up the vital thorax, whilst the bee was quite powerless to retaliate. (Kilosa, 27. iii. 22.)

98. Mantis religiosa L., ♀. The wings of this species were swarming with minute red mites. (Kilosa, 29. iii. 22.)

99. Pseudocreobotra wahlbergi Stål. Are mantids attracted to light like moths, or is it because of the moths they can capture that they come? I took two examples of this species at a light on the verandah last night. The eye-spots are seen to best advantage when the mantis raises its wings and rustles them in its usual "warning" attitude. (Frere Town, 2. vii. 19.)

100. Idolum diabolicum Sauss. Took an immature specimen of a chestnut-brown. The leaf-like outgrowth from the head reminded one of the Leaf-nosed Bats; other extravagant leaf-like outgrowths occurred from the limb-joints and on the thorax. (Dutumi, 15. ix. 16.)

I consider the species uncommon in East Africa, but as it is so procryptically coloured my conclusions may be based on my own poor observation. I have only captured two specimens in six years, the second was taken to-day. (Kilosa, 18. xii. 20.)

50. On the Guernsey *Crocidura*.

By Ivor G. S. Montague, F.Z.S., and Grace Pickford.

[Received October 11, 1923 : Read November 6, 1923.]

Among the material collected by G. E. Pickford in the Channel Islands in August and September 1923, is a series of twelve shrews from Guernsey. The examination of this series, and of four Guernsey shrews already in the British Museum collection, reveals a number of features which make it necessary to distinguish this race from the typical form *Crocidura russula russula*. The few Guernsey specimens examined by G. S. Miller *, though recorded as smaller than normal specimens of the large typical form of the Continent, were insufficient in number to make clear the characteristic nature of their dimensions. The uniformity of the small dimension throughout the now extended series leaves, however, no doubt of the distinct nature of the Guernsey race.

The following tabulation of the diagnostic characters of the European races of *C. russula* indicates their affinities.

C. r. russula Hermann.

Distribution. Central Europe, from Holland and Central Germany to the valley of the Garonne and the coast of South-Eastern France. Italy.

Diagnosis. Size rather large.

(*a*) Hind foot 11·7–14.
(*b*) Condylobasal length of skull 19–20·4.
(*c*) Average of 29 adults: HB. 78·3; T. 38·7: HF. 12·8.
Colour usually dark.

C. r. pulchra Cabrera.

Distribution. Central and Southern Spain. Lowlands of France south of the Gironde.

Diagnosis. Smaller than *C. r. russula*.

(*a*) Hind foot 10·8–13.
(*b*) Condylobasal length of skull 18–19·4.
(*c*) Average of 24 adults: HB. 72·8; T. 37·1; HF. 11·9.
Usually paler in colour than *C. r. russula*.

C. r. cintræ Miller.

Distribution. Cintra, Portugal.

Diagnosis. Size as in *C. r. pulchra*.

(*a*) Hind foot 11·4–12·7.
(*b*) Condylobasal length of skull 18–19·2.
(*c*) Average of 10 adults: HB. 67·6; T. 37·7; HF. 11·9.
Hairs with a peculiar strong coppery lustre.

* G. S. Miller, Catalogue of the Mammals of Western Europe, B.M., 1912.

C. R. PETA, subsp. n.

Distribution. Guernsey, Alderney (?).
Diagnosis. Size as in *C. r. pulchra.*
(*a*) Hind foot 11–12·5.
(*b*) Condylobasal length of skull 18·1–19·2.
(*c*) Average of 16 adults: HB. 68·3; T. 37·8; HF. 11·7.
Colour nearly as in *C. r. russula.*

CROCIDURA RUSSULA PETA, subsp. n.

Crocidura russula russula Miller, Cat. Mamm. W. E., B.M., 1912, p. 101.

Type locality. Guernsey.
Material examined. Four adults (3 ♂) collected by Bunting in August 1908 and twelve adults (7 ♂, 5 ♀) collected by Pickford in August and September 1923.
Dimensions:—
Type 8.9.2.20, adult ♂, 23 Aug. 1908. HB. 63·5. T. 39. HF. 12. E. 9.
Average of eleven adult males (8.9.2.18, ? 8.9.2.19, 8.9.2.20, 8.9.2.21, 1, 3, 4, 5, 5, 6, 9, 12):—
HB. 69·7; T. 37·9; HF. 11·7; E. 8·8.
Average of five adult females (2, 11, 23, 24, 25):—
HB. 65·2; T. 37·6; HF. 11·6; E. 8·6.
Condylobasal lengths of skulls:—(8.9.2.18) 19·2; (8.9.2.21) 19·0; (11) 19·0; (8.9.2.20) *Type* 18·8; (1) 18·8; (8.9.2.19) 18·2; (9) 18·1.
Remarks. The dimensions of this animal show throughout a uniform smallness which at once distinguishes them from those of the typical large form *C. r. russula.* The normal coloration is not to be differentiated from that of the dark typical form. The few light specimens, those collected in 1908, are probably only characteristic of the seasonal conditions in the presence of which a similar lightness occurs in *C. r. russula.* This occurrence of a light summer phase should not be confused with the lightness of *C. r. pulchra* which, as Miller (*l. c.*) noticed, normally occurs at all times of the year.
A *Crocidura* from Alderney in the British Museum collection should probably be grouped with the Guernsey form, but is too young to admit of positive identification.

NOTE.—The dimensions throughout this paper are in millimetres.

51. Reversible and Irreversible Evolution; a Study based on Reptiles. By Dr. FRANCIS, Baron NOPCSA.

[Received October 10, 1923: Read November 20, 1923.]

(Text-figures 8 & 9.)

The great amount of information that we have about the evolution of some groups of reptiles, the great amount of variability that these animals show, the long span of time that the history of their evolution covers, seem to make it advisable to base an investigation of the laws of evolution on the history of these groups. Fejérváry was one of the first who worked on these lines (**6**).

As is well known, in the skeletal structure of Reptilia many characters occur that show what has been called the irreversibility of evolution. Such characters are: the development of a secondary armour in *Dermochelys* (**4**), the changes in the pelvis of the orthopodous Dinosaurs (**5**), the secondary growth of the plastron in the Cinosternidæ (**9**), and the development of a new element (præpubis) functioning as pubis in the Crocodilia. Apart from these changes, some of which have been well studied, one can detect other less well-known changes tending to prove that sometimes a reversal of evolution can take place. Changes of this sort are: the secondary elongation of the anterior limbs in Dinosaurs, the development of the postorbital bar in Mammals and theromorphous reptiles, the redevelopment of more or less plate-like ventral pelvic elements in different reptiles, the occurrence of polygonal flat carpal and tarsal bones in highly specialised reptiles, and the relationship of the frontal to the orbit in different groups.

The aim of this paper is to give a description of the different changes of this second type and to draw conclusions.

§ (1) *The elongation of the anterior limbs in specialised Dinosaurs.*

In all primitive diaptosaurian reptiles, such as Rhynchosaurians and Parasuchians, and in a less marked degree in the true Rhynchocephalians, the anterior limbs are generally only a little shorter than the posterior. These animals are exclusively quadrupedal. In the short-necked Ornithosuchians and in the long-necked Proterosaurians, which were partly bipedal, a marked shortening of the anterior limbs can be detected. This shortening is stronger in the originally bipedal Dinosaurs. It is very noticeable in the lightly-built triassic carnivorous Dinosaurs (*Podokeosaurus*, *Hallopus*, *Procompsognathus*) but less marked in the jurassic and cretaceous representatives of this group. In *Procompsognathus* (and *Podokeosaurus*?) the ratio of the anterior limb to the posterior is 10/27, in the jurassic *Compsognathus* 10/18, in the nearly contemporaneous *Ornitholestes* 10/15, and in the cretaceous *Struthiomimus* 10/16. In this group, in which not the jaws or the posterior limbs but the anterior limbs were used for seizing the prey, a decided lengthening of the anterior limbs occurs. In the heavily-built carnivorous Dinosaurs, in which, much as in the birds of prey, a prehensile foot is developed, this elongation does not occur and the anterior limbs remain small or almost vanish (**10**).

A relatively short anterior limb is also met with in all bipedal orthopodous Dinosaurs. The ratio is 10/21 in *Hypsilophodon*, 10/23 in *Thescelesaurus*, 10/19 to 10/17 in *Camptosaurus*, 10/14 in *Iguanodon*, 10/17 in *Kritosaurus*, and 10/15 in *Corythosaurus*. Though less clearly than the preceding one, this list also shows that in the more specialised forms, as *Iguanodon* and *Corythosaurus*, the anterior limbs are a trifle longer than in the more primitive forms.

In the quadrupedal Sauropoda the anterior limbs are mostly shorter than the posterior; in one group, however, the Brachiosauridæ, the length of the limbs is nearly equal. In this case the secondary elongation is very marked (**10**).

All these data show that in those specialised Dinosaurs in which the anterior limb is continuously used a secondary lengthening of this part occurs. This can be considered as a reversal to the ancestral pro-dinosaurian type. Diagrammatically these changes can be expressed in the following manner:—

Anterior limbs long and functioning. *Anterior limbs short.*

Ancestors of Dinosaurs ⟶ Primitive Dinosaurs.

Specialised Dinosaurs ⟵

For one reason the case is not quite conclusive, for it can be surmised that the apparent secondary elongation is not due to a renewed growth but simply to the fact that in Dinosaurs the posterior limbs, on account of their being more used, grew big first, and that the growth of the anterior ones set in later. Since also such a hypothesis might explain the temporary disproportion of the limbs, the case must be considered doubtful.

§ (2) *The development of the postorbital bar.*

The second case to be dealt with is more typical than the first. While in all more or less primitive reptiles the postorbital bar is complete, it is open in some rather specialised forms. Such Reptiles are: many snake-shaped reptiles, some other lacertilians, and the Bauriamorpha. Contrary to what is known in Reptiles, in Mammals the postorbital bar is incomplete in the primitive forms and complete only in the younger Equidæ, most of the Artiodactyla, and in the Primates. This being the case, it may be concluded that all Mammals descended from animals lacking a postorbital bar.

In spite of many mammalian characters, such as the structure of the teeth, the articulation of the lower jaw, and the shape of the brain, not the Cynognathidæ but the Bauriamorpha must be considered as the ancestors of the Mammalia, for the ribs of the former show a non-mammalian trend of evolution. Curiously enough the Bauriamorpha have no postorbital bar. Thus the disappearance of this part in the Bauriamorpha and its reappearance in the higher mammals again points towards a reversal. Wortmann's discoveries of a separate postfrontal and even of a postorbital bar in some Insectivora (**19**) show that this part of the mammals is not analogous but homologous with the same part in reptiles.

This change seems again to be nothing else than the retention of an embryonic character in the adult, for frequently in embryos of animals characters appear that are later reduced. Good examples are afforded by the temporary development of a third cervical rib in the Lacertilia (**8**) and by the development of a fourth and fifth digit in embryos of birds (**13**).

A process similar to that which accounts for the development of the postorbital bar in higher mammals is evidently also changing the development of the claws in *Opisthocomus*, for this bird is evidently forgetting how to fly and learning how to climb (**10**).

For the history of the development of the postorbital bar in Reptiles and Mammals the following diagram can be drawn:—

$$\begin{tikzcd}
\textit{Postorbital bar complete.} & \textit{Postorbital bar incomplete.} \\
\text{Primitive Theriodonts} \arrow[r, dashed] & \text{Bauriamorpha (or similar Theriodonts).} \arrow[d] \\
\text{Specialised Mammalia} & \text{Primitive Mammalia.} \arrow[l]
\end{tikzcd}$$

§ (3) *The development of the ventral elements of the pelvis.*

As is well known, in primitive Stegocephalians, for example the Branchiosauridæ, the ventral elements of the pelvis consist of four, or sometimes even only of two, small disk-shaped centres of ossification that were evidently embedded in a large plate of cartilage. Much the same type of pelvis is found in the recent Urodeles. In the more specialised Stegocephalians (*Eryops*, *Cacops*) the two ventral elements form a continuous mass of plate-like bone with a small foramen perforating each pubis. It is evident that this type of pelvis originated in the complete ossification of the whole cartilage of the more primitive forms. This solid type occurs also in the Cotylosaurians (*Seymouria*, *Diadectes*, *Labidosaurus* (text-fig. 8 (1)), *Pareiasaurus*); in the most agile Cotylosaurians (*Procolophon*), however, and in the Pelycosaurians (*Ophiacodon*, *Varanosaurus*) a central perforation and separation of the pubis and ischium appear. From this latter type were evolved the pelves of the higher reptiles, that show either one great perforation in the centre and two small foramina obturatoria passing through the pubes, or one large foramen on each side between each pubis and ischium (text-fig. 8 (2)). Through this foramen the obturator nerve passes. As these openings grow larger the central pelvic elements are more or less reduced to rod-like bones. This change is analogous to the one that occurs in the skulls of different groups of reptiles, for also in these the originally plate-like skull bones are reduced, where they do not cover the brain-case, to rods that correspond to the different lines of stress and strain.

The tendency to develop more or less rod-like ventral pelvic elements is fairly well indicated in most tortoises (text-fig. 8 (3)), with the exception of the marine ones, for the median ossification is less marked in the modern tortoises than in the Amphichelydæ. The same structure is also observable in the primitive Sauropterygians (*Neusticosaurus* (text-fig. 8 (5)), *Anarosaurus*).

Among the Parapsida the rod-like pelvis is still missing in *Areoscelis* but clearly indicated in *Pleurosaurus* and well developed in all Squamata. Among the Rhynchocephalians large ventral pelvic openings are absent in *Howesia* and the Rhynchosaurains, but they are well developed in all other Rhynchocephalians (text-fig. 8 (7)) with exception of the Proganosauria. In all Thecodontia, all Dinosaurs, and all Crocodiles the pelvic apertures are always large.

In contrast with this more or less plate-like ventral pelvic elements are to be found in the specialised Sauropterygians (text-fig. 8 (6)), in the Proganosauria (text-fig. 8 (8)), and in the Pterosaurians. Among the latter this feature is very noteworthy, for it is especially well developed in the Pteranodontidæ, which are the most specialised members of the Order (text-fig. 8 (9)).

Dermochelys, which is derived from some unknown chelonian tortoise, has much smaller foramina obturatoria than all the Chelonidæ, and retains in the pelvis a great amount of cartilage throughout life (text-fig. 8 (4)). In this respect the pelvis of an adult *Dermochelys* recalls somewhat the pelvis of *Hatteria* in an early stage of development (**11, 14**). The resemblance which Baur (**1**) detected between the pelvis of some Testudinata and the pelvis of the Rhynchocephalia is, of course, only due to a case of convergence, for the situation of the foramen obturatorium is different in the two groups.

Comparing now the relationships of the reptiles mentioned in the above lines, it becomes clear that in three cases plate-shaped pelvic elements must have arisen from rod-shaped bones. The Plesiosaurians must have arisen from Nothosaurian reptiles, the Proganosauria from jurassic Rhynchocephalians, and the Pteranodontidæ from triassic Thecodontia. Thus these three cases are quite characteristic cases of reversal. An indication of the same sort of reversal is afforded by the differences that separate *Dermochelys* from the Chelonidæ. These differences show more clearly than the return of the postorbital bar in what manner such a reversal begins. As suggested in the former case, it starts by the retention of an embryonic stage throughout life.

Supposing that in *Dermochelys* the whole of the cartilage were to turn to bone, very soon a pelvis would evolve that would recall the most primitive reptilian pelvis. It would be more primitive than the pelvis of the Amphichelydæ. That such a reversal can actually take place will be proved in detail in the following paragraph, here it is enough to emphasise that in *Pteranodon* such an ossification actually did occur.

On account of the complexity of the changes in the ventral elements of the pelvis of reptiles the diagram also becomes complex.

Ventral part of pelvis to great extent cartilaginous, foramen obturatorium small.	*Bony plates with small foramen obturatorium.*	*Rod-like bones with large apertures.*
Primitive Stegocephalia →	Specialised Stegocephalia; primitive reptiles →	Specialised reptiles.
Primitive marine (and volant) reptiles ←		← Specialised reptiles.
Primitive marine (and volant) reptiles →	Specialised marine and volant reptiles	

§ (4) *Carpus and tarsus of reptiles.*

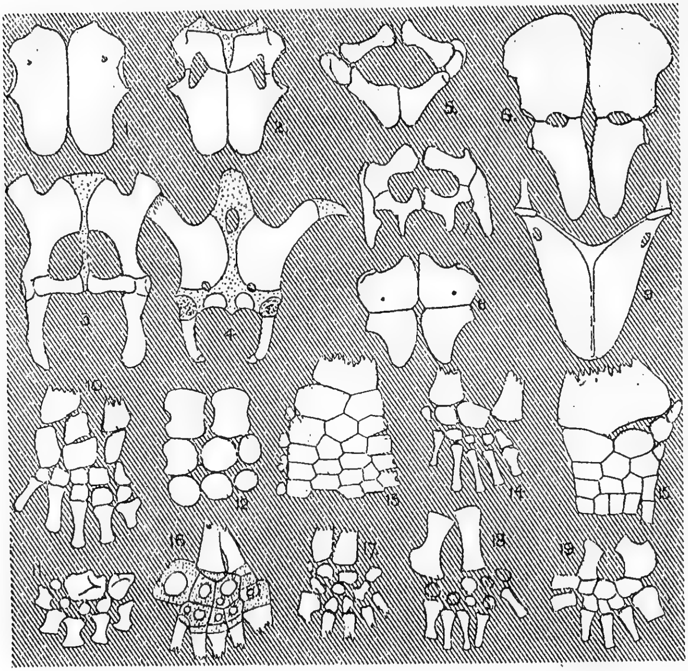
The changes that can be observed in the carpus and tarsus of reptiles are similar to those in the pelvis.

In primitive Stegocephalia, as in modern Urodeles, the carpus and tarsus consist of flat polygonal pieces of cartilage with small disk-shaped ossicles in their centre. In this respect it is sufficient to refer to *Uranocentrodon* and to *Scincosaurus*, the foot-bones of which have been figured by Broom (3). In other more reptile-like Stegocephalians carpus and tarsus consist no longer of cartilage but of more or less flat polygonal bones with but little cartilage between them (text-fig. 8 (10)) (*Trematops*). These tarsal and carpal bones evidently originated by the ossification of the whole or of nearly the whole cartilage of the primitive forms without much change in shape.

With the exception of the Procolophonidæ, the Cotylosauria show much the same sort of foot-bones as the Stegocephalia. In the primitive ones (*Diadectes*, *Disparactus* (text-fig. 8 (11), *Limnoscelis*), evidently polygonal cartilage plates were present with disk-like centres of ossification in their middle, while in the more specialised ones (Pareiasauridæ) the cartilage is replaced by polygonal bone. In the Procolophonidæ the structure of the foot-bones is different. Instead of cartilaginous or osseous, nearly immovable elements, ossicles with well-marked concave and convex surfaces of articulation are present. Probably a fair amount of cartilage was present, but probably also the surfaces of the cartilage-bodies were curved.

In the Pelycosaurians the carpus is still sometimes polygonal with a small amount of flexibility (*Ophiacodon*), sometimes rounded with a fair amount of cartilage (*Varanops*), and sometimes

Text-figure 8.



1. Plate-like pelvis of carnivorous primitive Cotylosaurian *Labidosaurus* (from Case).
2. Plate-like pelvis of carnivorous highly organised Theriodont *Cynognathus* (from Seeley).
3. Rod-shaped pelvis of moderately specialised marine tortoise *Chelone* (from Hofmann).
4. Cartilaginous plate-like pelvis of highly specialised marine tortoise *Dermochelys* (from Völker).
5. Rod-shaped pelvis of semi-aquatic Sauropterygian *Neusticosaurus* (from Fraas).
6. Plate-like pelvis of highly organised marine Sauropterygian *Peloneustes* (from Linder).
7. Rod-like pelvis of terrestrial Rhynchocephalian *Sauranodon* (from Lortet).
8. Plate-like pelvis of aquatic Rhynchocephalian *Champsosaurus* (from B. Brown).
9. Plate-like pelvis of highly specialised Pterosaurian *Pteranodon* (from Eaton).
10. Polygonal tarsus of highly specialised Stegocephalian *Trematops* (from Williston).
11. Disk-shaped cartilaginous tarsus of primitive Cotylosaurian *Disparactus* (from Case).
12. Disk-shaped carpus of primitive Ichthyosaurian *Delphinosaurus* (from Merriam).
13. Polygonal carpus of highly specialised Ichthyosaurian *Ichthyosaurus* (from Huene, referred to there under the generic name *Eurypterygius*).
14. Disk-shaped carpus of primitive Sauropterygian *Proneusticosaurus* (from Volz).
15. Polygonal carpus of specialised Sauropterygian *Polycotylus* (from Williston).
16. Disk-shaped carpus of highly specialised marine tortoise *Dermochelys* (from Völker).
17. Spherical carpus of primitive marine tortoise *Toxochelys* (from Hay).
18. Disk-shaped carpus of primitive Mosasaurian *Tylosaurus* (from Osborn).
19. Polygonal carpus of specialised Mosasaurian *Platecarpus* (from Williston).

well ossified with spherical surfaces of articulation (*Dimetrodon*). The latter type is to be found also in all terrestrial Squamata that have well-developed feet. Very little is known until now about the foot-bones of the Theromorpha; they seem, however, always to have attained a high degree of perfection.

Turning from the monozygocrotaphous Theromorpha to the likewise monozygocrotaphous Sauropterygians, which evidently descended from Pelycosaurians or Theromorpha, one is surprised to remark that even in those Sauropterygians that are least adapted to aquatic life (*Neusticosaurus*, *Proneusticosaurus* (text-fig. 8 (14)) the foot-bones are flat and rounded ossicles that evidently formed the centres of cartilaginous, polygonal plates. The same sort of foot-bones are present in the liassic Plesiosaurians. In the more specialised later Plesiosaurians, instead of the cartilaginous plates, polygonal flat bones are present. The flat polygonal bones observable in *Elasmosaurus*, *Polycotylus* (text-fig. 8 (15)) or *Cimoliosaurus* recall somewhat the flat polygonal bones of the specialised Stegocephalians.

Similar changes as those in the Sauropterygians can also be observed in the Ichthyopterygians. In *Mesosaurus* and some triassic Ichthyosaurians (*Shastasaurus*, *Delphinosaurus* (text-fig. 8 (12)) round bony disks occur that were evidently surrounded by extensive cartilage. In all the more specialised Ichthyosaurians (text-fig. 8 (13)) polygonal bony plates are present. These are firmly applied against each other.

Somewhat similar changes as in these groups are to be met with in the Testudinata. In the terrestrial tortoises polygonal bones occur with a small amount of mobility between them. In the Trionychidæ these bones show by retaining at their angles a good amount of cartilage a tendency to round off these angles. In the Chelonidæ (text-fig. 8 (17), *Toxochelys*) this process is still more marked; finally, in *Dermochelys* (text-fig. 8 (16)) instead of angular bones, polygonal plates of cartilage are present, with flat bony disks in the centre. These changes show that the rounding off of the primitive polygonal foot-bones of the Testudinata is due to the retention of an embryonic stage throughout life (**14**).

Applying this observation to the fossil marine forms hitherto discussed, it becomes obvious that also in these first a cartilaginous embryonic stage, with small centres of ossification, had become permanent for some time, and that after this transitory stage extensive ossification set in, in much the same manner as in the most primitive reptiles. In this instance it will be remembered that the hypothesis of a secondary ossification has already been brought forward in the foregoing paragraph.

Among the marine Squamata the carpal and tarsal bones retain spherical articulating surfaces in *Opetiosaurus*, they have become to a great extent cartilaginous in *Tylosaurus* (text-fig. 8 (18)), and are already to some extent replaced by flat polygonal bones in *Platecarpus* (text-fig. 8 (19)). So also in this group the same changes occur as in the groups already dealt with.

Until the present investigation only the shape of each isolated foot-bone was dealt with, now it becomes necessary to consider the whole foot. While each separate foot-bone shows a decided reversal of evolution, the whole foot as such shows something else. Although several of the carpal and tarsal bones can be identified in all groups of reptiles, nevertheless the number and the relative position of the foot-bones continually change. This is why the foot of an Ichthyosaurian can readily be distinguished from the foot of a specialised Stegocephalian. In consequence of the foot-bones always being differently arranged in the different groups of reptiles, evolution seems to be irreversible.

Thus the foot-bones of reptiles show in a drastic manner how in one point of an organ the evolution can be reversible, but irreversible in another. When such a phenomenon occurs in correlated parts of the body, it is admissible to call the case a mixed one.

The diagram representing the evolution of the foot-bones of reptiles recalls the one of the evolution of the pelvis :—

Tarsus and carpus polygonal cartilaginous plates.	*Polygonal bony plates.*	*Bones with spherical surfaces.*
Primitive Stegocephalians / „ Cotylosaurians →	Specialised Stegocephalians / „ Cotylosaurs →	Higher reptiles.

Primitive marine reptiles ← Higher reptiles.

Primitive marine reptiles → Specialised marine reptiles.

§ (5) *The development of the supraorbital region.*

In nearly all the Stegocephalians the postfrontal and the prefrontal meet above the orbit and exclude the frontal from this opening. It is only in some highly specialised forms that exceptions to this rule can be found. First of all the frontal touches the orbit in those gigantic and, as Watson (**15**) proved, specialised forms, such as *Capitosaurus*, *Mastodonsaurus*, and *Cyclotosaurus*; secondly, this occurs in those Labyrinthodonts that show a very marked broadening of the skull, such as *Plagiosaurus* (text-fig. 9 (4)); thirdly, this occurs in the aberrant Microsaurian *Diplocaulus* (text-fig. 9 (2)). In the less aberrant relatives of *Plagiosaurus* and *Diplocaulus* as, for example, *Batrachosuchus* (text-fig. 9 (3)), *Diceratosaurus*, and *Batrachiderpetum* (text-fig. 9 (1)), the frontal is yet excluded from the orbit.

Other Stegocephalians, in which the frontal likewise borders the orbits, are *Gephyrostegus*, which is characterised by the thinning out of the cranial roof, suggesting the formation of temporal vacuities, and *Trematops* and *Broiliellus*, that both recall the Cotylosauria. From all this it becomes evident that in the Stegocephalia the entry of the frontal into the orbits is a sign of specialisation. For the sake of convenience one can call the type where it enters into the orbit the *neo-orbital* type and retain the expression *palæo-orbital* for the other.

Among the Cotylosauria the Diadectidæ (text-fig. 9 (5), *Diadectes*), Pareiasauridæ, and Limnoscelidæ show the same structure as the primitive Stegocephalians, the Captorhinimorpha and the Procolophonidæ the other. *Procolophon* (text-fig. 9 (6)) is a very agile Cotylosaurian, showing also many other signs of specialisation: for example, a small lacrymal bone. In the Captorhinimorpha, on the other hand, the limbs are specialised to a rather high degree.

Among the Testudinata that are somewhat allied to the Cotylosaurians, the relation of the frontal to the orbit varies. In some primitive Testudinata, such as *Triassochelys*, *Chisternon*, and *Kallokibotium*, the palæo-orbital type is preserved; in some other Amphichelydæ already the neo-orbital type occurs. Curiously enough, the palæo-orbital type occurs also in the Protosteginæ and the Dermochelydæ (text-fig. 9 (8)), while the Lytolomidæ and the Chelonidæ (text-fig. 9 (7), *Toxochelys*) show the neo-orbital type. In primitive Chelonidæ (*Toxochelys*) and in the embryos of *Chelone* (**14**) the neo-orbital type is more marked than in the adult *Chelone*. In the rest of the Tortoises generally the neo-orbital type is met with; the palæo-orbital type occurs, however, in the Platysterninæ and Chelydridæ, and sporadically among the Emydidæ.

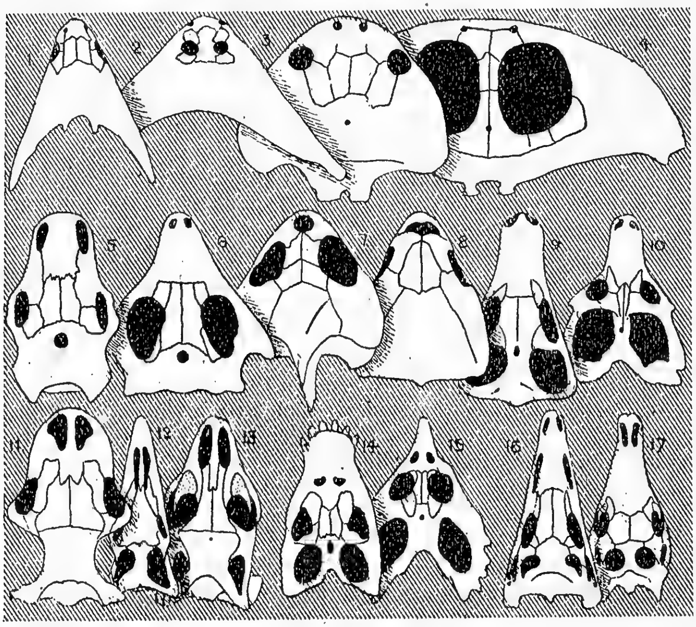
In *Platysternum*, *Dermochelys*, and some Chelydridæ, as *Macroclemmys*, the palæo-orbital type is associated with a secondary enlargement of the bones forming the roof of the skull and with the loss of the power of hiding the head under the shield. In accordance with this, in *Dermochelys*, *Chelone*, and *Chelydra*, the posterior excavation of the parietal and the squamosal is more marked in the embryos than in the adult (**14**).

Considering that in the most primitive Tortoises the capacity of withdrawing the head had not yet been acquired, and that it was but secondarily lost in *Dermochelys*, *Chelone*, *Platysternum*, and *Macroclemmys*, it becomes evident that this feature and the palæo-orbital type are connected with each other. Evidently the palæo-orbital type of the more specialised Tortoises has been developed from the neo-orbital type, for the ontogenetical changes observable in the Chelonidæ point in this direction.

Among the Theromorpha the neo-orbital type dominates *Microgomphodon* (text-fig. 9 (9)). The palæo-orbital type is only met with in the Cynognathidæ (*Protacmon*, text-fig. 9 (10)). In consequence of this it must be assumed that either the Cynognathidæ retained a very ancient structure, or that also in this case a reversal took place. Since in all Pelycosaurians that are ancestral to the Theromorpha the neo-orbital type likewise occurs, evidently the latter has to be assumed. As Pelycosaurians, it is quite enough to mention the genera *Varanosaurus*, *Sphenacodon*, *Theropleura*, and *Dimetrodon*.

Among the Placodontidæ, palæo-orbital genera as *Placodus* (text-fig. 9 (14)) and neo-orbital genera as *Placochelys* (text-fig. 9 (15)) can be distinguished. Unfortunately nothing is known about the evolution of this group, therefore no conclusions can be drawn.

Text-figure 9.



1. Palæo-orbital skull of primitive Microsaurian Diplocaulidæ, *Batrachiterpeton* (from Watson).
2. Neo-orbital skull of specialised Microsaurian Diplocaulidæ, *Diplocaulus* (from Douthitt).
3. Palæo-orbital skull of primitive Stereospondylous Brachyopidæ, *Batrachosuchus* (from Watson).
4. Neo-orbital skull of specialised Stereospondylous Brachyopidæ, *Plagiosaurus* (from Fraas).
5. Palæo-orbital skull of primitive Cotylosaurian *Diadectes* (from Hueno).
6. Neo-orbital skull of specialised Cotylosaurian *Procolophon* (from Woodward).
7. Neo-orbital skull of primitive marine tortoise *Toxochelys* (from Hay).
8. Palæo-orbital skull of specialised marine tortoise *Dermochelys* (from Völker).
9. Neo-orbital skull of primitive higher Theriodont *Microgomphodon* (from Watson).
10. Palæo-orbital skull of specialised higher Theriodont *Protacmon* (from Watson).
11. Palæo-orbital skull of Lepidosaurian *Heloderma* (from Phisalix).
12. Neo-orbital skull of Lepidosaurian *Platecarpus* (from Williston).
13. Tectorbital skull of Lepidosaurian *Varanus* (from Schmidt).
14. Palæo-orbital skull of Dranitesaurian *Placodus* (from Broili).
15. Neo-orbital skull of Dranitesaurian *Placochelys* (from Jaekel).
16. Neo-orbital skull of primitive Archosaurian *Euparkeria* (from Broom).
17. Tectorbital skull of specialised Archosaurian *Camptosaurus* (from B. Brown).

Among the Sauropterygians, the neo-orbital type is met with in *Anarosaurus*, *Pistosaurus*, and *Nothosaurus*, the palæo-orbital type in *Cymatosaurus* and all Plesiosaurians. In all the Plesiosaurians the frontal shows a decided tendency to vanish altogether, and, besides this, in the more specialised long-snouted Plesiosaurians (the Pliosaurians) the tendency exists to develop large supraorbital bones. This tendency is well observable in the genera *Peloneustes*, *Brachyauchenias*, and *Trinacromerum*. In these genera the prefrontals and postfrontals are long and narrow bones. On account of the reduction of the frontal these animals revert at first to the palæo-orbital type, but when the broadening of the head sets in they develop on other lines.

In the Parapsida, that include the Areoscelia, the Acrosauria, and the Squamata, the frontal nearly always separates the prefrontal and the postfrontal. While it borders the orbit in *Areoscelis*, *Pleurosaurus*, all primitive Chameleons (**18**) and many Lacertilians (*Platecarpus*, text-fig. 9 (12)), it is excluded in some Lacertilians from the orbit by a supraorbital bone (text-fig. 9 (13), *Varanus*). *Heloderma* (text-fig. 9 (11)) and the specialised Chameleons (**17**) differ from all the other Squamata in showing the palæo-orbital structure, but this may be due to a reversal. Thus in this group the structure varies.

In the Diaptosaurians (text-fig. 9 (16), *Euparkeria*), the Dinosaurs, and the Crocodiles, the prefrontals and the postfrontals never meet. In some Crocodiles however, and in the orthopodous Dinosaurs supraorbital bones are developed (text-fig. 9 (17), *Camptosaurus*).

For the neo-orbital type, in which a supraorbital bone is present, Fejérváry's term, *tectorbital* (**7**), can be adopted. Since the supraorbital bone is only developed in few groups of reptiles, the tectorbital type is evidently new.

Proceeding now to group the primarily palæo-orbital, the neo-orbital, the secondarily palæo-orbital, and the tectorbital types according to chronological order, it is soon seen that the primarily palæo-orbital types are either permian reptiles or such that are closely allied to permian reptiles. The neo-orbital type occurs in different groups from the Permian upwards, it is most marked in the most advanced reptiles; the secondarily palæo-orbital forms are found from the Trias upwards, but mostly among comparatively low postcretaceous reptiles; finally tectorbital types occur exclusively from the Jurassic upwards.

The average conclusion to be drawn is that in primitive reptiles (Cotylosauria, Tortoises) a reversal could easily occur from the neo-orbital type to the palæo-orbital type; that, however, in the more highly developed reptiles (Crocodiles, Dinosaurs) the broadening of the skull could no longer be attained by a reversal but only by the development of a new bony element. Comparatively primitive reptiles, as Sauropterygia and Squamata, seem to be intermediate between the two extremes. The primitive nature of the Squamata is best shown by the circulatory and respiratory organs.

In two most important papers Weidenreich (**16, 17**) pointed out that in some living animals characters occur that are very characteristic and date back at least to Pliocene time, but that are all the same not yet perfectly fixed. Such characters have each time to be acquired by a special stimulus in every individual. When such a stimulus is lacking a reversal to the ancestral type takes place. Such characters are, for example, among many other ones, the blindness of *Proteus* (**16**) and the shape of the calcaneus in man (**17**).

Other characters, as the development of the foramen of the operculum, through which, in the Urodela, the extremities are protruded (**16**), or the scrotum of man (**16**), are even then developed to a certain degree, when inciting stimuli, as the pressure of the extremities against the operculum or the descent of the testicles are not acting, but in such cases these characters are less marked than when the stimuli are acting.

A third group of characters is always developed in ontogenesis, and even apparently without reason. These observations show that in the fixing of new characters quite different stages occur.

Comparing now these stages with the changes found in the orbital region, it is evident that the reversal of the neo-orbital structure to the palæo-orbital type in permian or primitive reptiles (Tortoises) is entirely analogous to the case when a not yet fixed character is lost again. The undecided condition prevailing among the Sauropterygians and the Squamata can be well compared to the changes in Weidenreich's second group, and the development of the tectorbital type shows that in the highly developed reptiles the neo-orbital type had become fixed to such an extent that a reversal was no more possible.

In this way palæontological observations corroborate zoological research, and the interest of this case lays in that it is correlated with geological time.

The changes may be shown diagrammatically as follows:—

Palæo-orbital type.	*Neo-orbital type.*	*Tectorbital type.*
Primitive Stegocephalians, ,, reptiles ↘	Specialised Stegocephalians, prejurassic reptiles ↓	
Specialised prejurassic reptiles ↙	Specialised post-jurassic reptiles →	Specialised post-jurassic reptiles.

(The explanation of the abbreviated terms "prejurassic" and "postjurassic" is given in the text.)

Conclusion.

After having discussed five cases of reversible evolution, four of which are beyond question, and after having mentioned at the beginning of the paper several cases of irreversible evolution, conclusions may now be drawn.

The first certain case of reversible evolution shows how an ossification, which was interrupted during the course of evolution, sets in again. The second case shows the persistence of a primitive stage of development in later more specialised forms, and shows the subsequent development of another stage of evolution through which the ancestral forms had passed long ago. The third case, the mixed one, shows a similar change coupled with "irreversible" evolution, and finally in the fourth case three phases can be discerned—one phase, in which a character is not yet fixed, so that a reversal is possible, a second undetermined phase, and a third, in which a reversal is impossible. In the latter case a particular function can only be attained by the development of a new organ.

Reviewing the "irreversible" cases, it can easily be detected that the apparent "irreversibility" is always due to the fact, that either an adjacent organ or an organ having a similar function is called upon to replace a degenerating organ or that in the absence of such parts a new organ is developed.

From the combination of these observations the following statements can be deduced:—

(1) An apparent irreversibility will occur when a certain character is already so strongly fixed that it cannot be altered. Such a fixation will occur all the sooner if the dismissed organ acquired a new function.

(2) An apparent irreversibility will occur when some function is not perfectly concentrated in a special organ, so that similarly functioning organs are ready at hand to replace each other.

(3) An apparent irreversibility will occur when an adjacent organ is ready to replace the more or less degenerated one. As an example of this sort the pelvis of the Crocodiles may be mentioned, for in this case the posterior ventral ribs assumed the function of the degenerated pubis and became the prepubes (new hypothesis of the author).

(4) Evolution will appear irreversible when in some organ the possibility of development still exists—*i. e.*, if the organ is yet in a primitive unspecialised state. In such a case this part is ready to develop new features that can replace another degenerating organ. An example of this case is afforded by the development of the secondary dermal armour in *Dermochelys*. As Schmidt's investigations (**12**) showed, the skin of the Tortoises is not yet strongly modified in the young, and so it has evidently not yet lost the general faculty of developing dermal ossifications.

When one of the four enumerated ways of solving a biological problem has become impossible, an animal can only be saved from extinction by a reversal to an embryonic stage. This will only be possible—

(1) if the state to be given up is not yet fixed by heredity. That means if this state is not very far back in the history. A good example is afforded by the development of the supraorbital region;

(2) if the embryonic state to be called upon has not in the meantime acquired a new and vital function. For this case

Salamandra atra is a good example, for if the gills of this Urodele were more adapted to the interuterine breathing than they actually are, the rearing of its larvæ in water would become impossible (**16**). Even in Tortoises evidently the embryonic gills are already modified to such an extent that the Mud-Tortoises were incapable of falling back on the use of their gills, and had in the course of their aquatic adaptation to develop new pharyngeal organs for breathing under water.

The unexplainable but important fact, that the life-history of each individual is always a distorted recapitulation of the history of its whole phylum, gives the clue by which we can understand why a limited reversal of evolution can occur.

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52. On New and Rare Reptiles from South America. By JOAN B. PROCTER, F.Z.S., F.L.S., Curator of Reptiles to the Society, formerly in charge of the Reptile Collections in the British Museum (Natural History).

[Received November 12, 1923: Read November 20, 1923.]

(Text-figures 1 & 2.)

The British Museum has recently acquired two interesting collections of Reptiles and Batrachians from South America. The first was made by Mr. A. C. McDougall in Trinidad, on the River Mamore, Bolivia, and presented in 1922. It includes a very interesting new snake of the genus *Oxybelis* which I have named *boulengeri* after Mr. G. A. Boulenger, who has given me so much help and encouragement in my work during the past seven years. The second is a large collection from Marajo Island, at the mouth of the Amazon. This was made by Herr W. Ehrhardt, and it includes many rarities and a new species of *Amphisbæna* which I have much pleasure in naming *mitchelli* after Dr. P. Chalmers Mitchell.

Complete lists of the species collected are appended for their geographical interest, but for the sake of brevity, notes on the more common species are omitted.

I.—*The McDougall Collection from Bolivia.*

ECAUDATA.

BUFONIDÆ.

1. BUFO GRANULOSUS Spix.

LACERTILIA.

TEIIDÆ.

2. PANTODACTYLUS SCHREIBERSII Wiegm.

IGUANIDÆ.

3. POLYCHRUS MARMORATUS L.

OPHIDIA.

GLAUCONIIDÆ.

4. GLAUCONIA ALBIFRONS Wagl.

ILYSIIDÆ.

5. ILYSIA SCYTALE L.

COLUBRINÆ.

6. HELICOPS POLYLEPIS Gthr.

One half-grown specimen is beautifully marked; the white spots on the dark brown ventrals form a paired series, and the throat has a transverse white band as well as the usual spots.

The throat of this specimen is puffed out in a similar manner to that of an angry *Dispholidus* or *Spilotes*.

7. HERPETODRYAS CARINATUS L.

8. LIOPHIS PŒCILOGYRUS Wied.

9. RHADINÆA COBELLA L.

10. XENODON MERREMI Wagl.

DIPSADOMORPHINÆ.

11. LEPTODIRA ANNULATA L.

12. OXYRHOPUS PETOLARIUS L.

13. O. BITORQUATUS Gthr.

14. O. CORONATUS Schneid.

15. OXYBELIS BOULENGERI, sp. n.

Habit very slender; eye large.

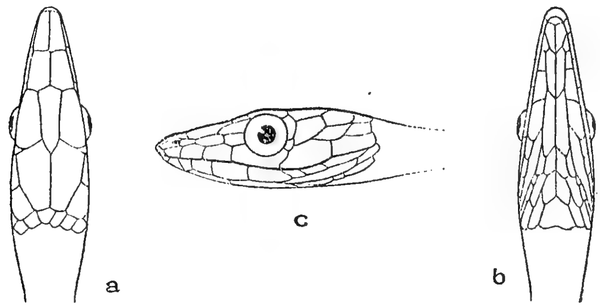
Snout twice as long as eye, tapering, truncated at tip. Rostral broader than deep, scarcely visible from above; internasals slightly shorter than præfrontals; frontal long, elegantly shaped, three times as long as broad, as long as the parietals, as broad as the supraoculars; loreal small, elongate, three to four times as long as deep; præocular large, widely separated from the frontal. Eye large, diameter three times its distance from lip, going five and a half times into total head-length; two or three postoculars (differing on the two sides); temporals 1+2; six upper labials, the fourth very large and surrounding the lower third of the eye-rim; four lower labials in contact with the anterior chin-shields, which are much shorter than the posterior pair. Scales smooth, in 17 rows; ventrals deeply rounded, 102 in number; anal divided; subcaudals in 190 pairs.

Body olive above, with two darker narrow lateral streaks on the fifth scale-row of each side, fading into bright green on the third and fourth and cream-colour on the first and outer edge of ventrals. A broad bright dark green band occupying the true ventral surface with a median pale green streak. Tail olive-green above and below, with a cream lateral stripe which fades into pale green and disappears on the posterior half.

Head brown-olive above, bright green on the sides; a dark brown-olive streak from snout-tip, through eye, continuing down neck as the lateral streak; lips and chin pale yellow-green.

Type-specimen a half-grown male collected in Trinidad, River Mamore, Bolivia.

Text-figure 1.



Oxybelis boulengeri, sp. n.
Head: *a.* dorsal view; *b.* ventral view; *c.* lateral view.

This charming snake is allied to *O. argenteus* Daud., which it resembles in the proportions of the snout and in the fourth upper labial alone entering the eye-rim. It differs in many characters, however, which are best shown by tabulation.

O. argenteus.	*O. boulengeri*, sp. n.
Eye: moderate, 7 times in total head-length.	large, 5½ times in total head-length.
Frontal: 3 times as long as broad.	4 times as long as broad.
Anal: entire.	divided.
Throat: with regular punctations.	immaculate.
Coloration: upper surface light brown; ventrals cream, with 2 wide green lateral and a slender median streak.	upper surface olive; ventrals dark bright green with pale median streak.

ELAPINÆ.

16. ELAPS SPIXII Wagl.

One female measuring about 3 feet.

So far as I am aware this rare *Elaps* has not previously been recorded from Bolivia. When the British Museum Catalogue was published the collection only contained three small specimens, in which the eye was larger in proportion, measuring two-thirds its distance from the mouth. In fully adult specimens the diameter of the eye is only half its distance from the mouth.

AMBLYCEPHALIDÆ.

17. LEPTOGNATHUS CATESBYI Sentz.

II.—*The Ehrhardt Collection from Marajo Island, at the mouth of the Amazon.*

BATRACHIA ECAUDATA.

CYSTIGNATHIDÆ.

1. PALUDICOLA SIGNIFERA Gir.

2. LEPTODACTYLUS PENTADACTYLUS L.

3. L. MYSTACINUS Burmeist.

4. L. TYPHONIUS Daud.

BUFONIDÆ.

5. BUFO GRANULOSUS Gthr.

5 specimens ♂ ♀.

One male has lost the right hand, and the nuptial excrescences are enormously developed on the inner side of the wrist stump, so much so that they form a protuberant mass which is obviously as useful for holding the female as a normal hand.

HYLIDÆ.

6. HYLA TAURINA Fitz.

7. H. VENULOSA Laur.

8. H. RUBRA Daud.

9. PHYLLOMEDUSA HYPOCHONDRIALIS Daud.

LACERTILIA.

GECKONIDÆ.

10. GONATODES HUMERALIS Guich.

11. THECADACTYLUS RAPICAUDUS Houtt.

12. HEMIDACTYLUS MABOUIA Moreau.

IGUANIDÆ.

13. ANOLIS ORTONII Cope.

14. POLYCHRUS MARMORATUS L.

15. OPHRYOESSA SUPERCILIOSA L.

16. UROCENTRON AZUREUM L.

Five specimens of this rare lizard, all brilliantly marked.

17. IGUANA TUBERCULATA Laur.

18. AMEIVA SURINAMENSIS Laur.

A magnificent series of specimens.

AMPHISBÆNIDÆ.

19. COPHIAS FLAVESCENS Bonn.

One adult female of this extremely rare species. It agrees in every particular with the specimens already in the British Museum, and with the description in the Catalogue of Lizards, vol. iii. p. 418.

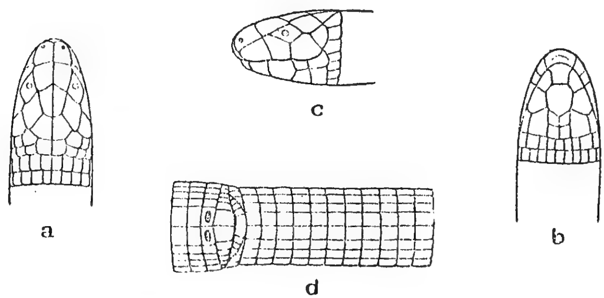
20. AMPHISBÆNA ALBA L.

21. AMPHISBÆNA MITCHELLI, sp. n.

Habit as in *A. vermicularis*.

Snout obtusely pointed, rather prominent. Rostral small, as deep as broad, scarcely visible from above; nasals large, forming a suture behind the rostral, which is slightly longer than the one between the præfrontals; frontal suture longer than the præfrontal suture; two pairs of small parietals. Eye distinct through the ocular; no præocular; postocular large, pentagonal; a single triangular anterior temporal; three large and one small upper labial on each side, third in contact with ocular and postocular. Symphysial tetragonal followed by a large heptagonal median chin-shield; two large posterior chin-shields in contact

Text-figure 2.



Amphisbæna mitchelli, sp. n.
Head: *a.* dorsal view; *b.* ventral view; *c.* lateral view.
d. Anal region: ventral view.

with second and third sublabials, separated from each other by 4 small shields. Body slender, composed of 213 annuli; 14 segments above and 14 below the lateral grooves, which are well-defined. Each segment above about twice as long as broad; median ventrals twice as broad as long; a vertebral groove. Tail composed of 30 annuli. Anal 4 segments wide, the two median enlarged; 2 præanal pores.

Upper surface a soft brown, each segment light-edged. Snout and lower surfaces écru.

Described from a single adult from Marajo Island, mouth of the Amazon.

This very distinct species may at once be recognized by its relatively long nasal suture, large anterior temporal, and single pair of præanal pores. It does not seem to be very closely related to any other species.

SCINCIDÆ.

22. MABUIA AURATA Schneid.

OPHIDIA.

TYPHLOPIDÆ.

23. TYPHLOPS RETICULATUS L.

COLUBRINÆ.

24. HELICOPS LEOPARDINUS Schleg.

The British Museum has only received one specimen of this rare snake since 1869.

25. DRYMOBIUS BODDAERTI f. t. Sentz.

26. COLUBER CORAIS Boie.

27. HERPETODRYAS CARINATUS L., var. E (FLAVOLINEATUS Jan).

28. LEPTOPHIS LIOCERCUS Wied.

29. LIOPHIS PŒCILOGYRUS Wied.

30. L. REGINÆ L.

Five hgr. and yg.

These specimens are brown on the upper surfaces, salmon-pink blotched with black beneath, and strikingly similar to *Rhadinæa cobella* in general coloration.

DIPSADOMORPHINÆ.

31. HIMANTODES CENCHOA L.

32. OXYRHOPUS TRIGEMINUS D. & B.

Two males.

The markings in this species are widely variable; the middle black band of each set of three may be much broader than the outer two, and rounded like a hugh lozenge-shaped spot. The paired white rings may be very narrow indeed, or equal to the black ones in width.

33. PHILODRYAS VIRIDISSIMUS L.

34. OXYBELIS FULGIDUS Daud.

35. O. ACUMINATUS Wied.

36. HOMALOCRANIUM MELANOCEPHALUM L.

ELAPINÆ.

37. ELAPS SPIXII Wagl.

One ♂, similar to the specimen already noted in the McDougall collection. Both these specimens have very much swollen cheeks, and minute eyes half or less than half their distance from the mouth in diameter.

38. ELAPS MARCGRAVII Wied.

The white band across the præfrontals and 2nd and 3rd labials is well marked; eleven sets of annuli on the body, the white rings being $\frac{1}{3}$ the width of the black ones.

53. On New and Rare Reptiles and Batrachians from the Australian Region. By JOAN B. PROCTER, F.Z.S., F.L.S., Curator of Reptiles to the Society.

[Received November 12, 1923: Read November 20, 1923.]

(Text-figures 3 & 4.)

Several interesting collections from the Australian Region have recently been received by the British Museum (Nat. Hist.). I shall include four in this one paper, and limit it for the sake of brevity to notes on rarities and descriptions of new species.

I.—NEW GUINEA.

Mr. W. Potter recently collected for the Museum in N.E. New Guinea, and besides large series of the commoner things, obtained several rare lizards and a new skink. The latter I have named after Mr. C. J. Battersby, who has been a most helpful assistant to me throughout the time that I was in charge of the Museum's collections of Reptilia and Batrachia.

LACERTILIA.

GECKONIDÆ.

GYMNODACTYLIS LORIÆ Blgr.

A male (length: head 45 mm., body 110 mm., tail missing), at least twice as large as the male type-specimen, the only individual already in the Collection; in other particulars the two specimens are identical.

GYMNODACTYLUS LOUISIADENSIS de Vis.

A very large well-preserved female (length: head 35 mm., body 93 mm., tail 47 mm.). The three specimens of this rare Gecko already in the Museum are from the D'Entrecasteaux Group and the Solomon Islands.

PYGOPODIDÆ.

LIALIS JICARI Blgr.

One adult of this extremely rare Pygopod was collected at Lababia. Each dorsal scale, with the exception of the two median series, has a small black apical dot, and is also finely speckled. The species was only known from the three type-specimens.

SCINCIDÆ.

LYGOSOMA (LIOLEPISMA) VIRENS Peters.

Four of these sharp-nosed skinks were collected on the banks of the River Adler, Huon Gulf.

LYGOSOMA (LIOLEPISMA) LONGICEPS Blgr.

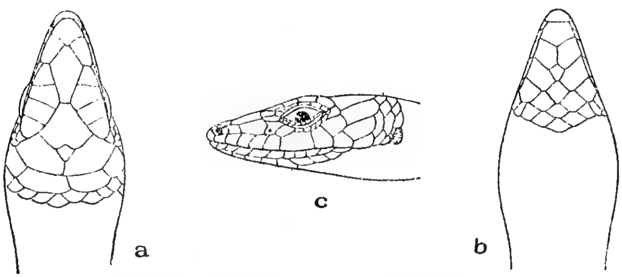
One very well-marked adult from Lae.

The digits are depressed with smooth lamellæ below as far as the end joint; the distal phalanx is slender and compressed, and the digits therefore resemble those of a *Hemidactylus*.

LYGOSOMA (EMOA) BATTERSBYI, sp. n.

Snout moderate in length, obtusely pointed. Rostral small, twice as broad as deep, forming a suture with the frontonasal, which is broader than long and roundly pointed anteriorly; frontal three-fifths broad as long, as long as fronto- and interparietals together; frontoparietals fused; interparietal small, distinct; parietals forming a short median suture, and followed by a pair of enlarged nuchals. Nostril pierced between a minute nasal, small postnasal, and supranasal; frontonasals separated from each other; lower eyelid with a transparent disk; sixth upper labial in place of subocular. Ear-opening small, not as

Text-figure 3.



Head of *Lygosoma* (*Emoa*) *battersbyi*, sp. n.
a. dorsal view; *b.* ventral view; *c.* lateral view.

large as the transparent palpebral disk; one auricular lobule. Digits long, distally compressed; thirty smooth lamellæ under fourth finger, forty under fourth finger, forty under fourth toe.

Scales in thirty rows; sharply tri- or quinquecarinate. Marginal anals slightly enlarged.

Habit lacertiform; the distance between the tip of the snout and the fore-limb equals the distance between axilla and groin; the hind-limb reaches to in front of the shoulder when adpressed. Tail nearly twice length of head and body.

Olive-green above, lighter on the head; opalescent beneath. An indistinctly marked light lateral band, black-edged.

A single adult specimen from Huon Gulf, N.E. New Guinea.

Allied to *L. tropidolepis* Blgr.*, from which it differs in having the interparietal shield distinct and the marginal præanals enlarged.

II.—QUEENSLAND.

Two collections are considered in this chapter. One made by Mr. T. V. Sherrin in Ravenshoe, N. Queensland, includes several rare species until now unrepresented in the Museum's collection. The other, made by Capt. Wilkins in S.E. and C. Queensland, although small, also includes rare things.

ECAUDATA.

Cystignathidæ.

Limnodynastes fletcheri Blgr.

Wilkins Collection. St. George's District, C. Queensland.

One male specimen of this rare frog was obtained. The skin is glandular and the markings clearly defined, spots in paired lateral series beginning on the loreal region and continuing from the temporal; a large shield-shaped occipital blotch and large median dorsal and sacral markings. Basal web between the toes well marked.

Originally described from New South Wales †, but recently recorded from S. Queensland.

Engystomatidæ.

Sphenophryne variabilis Blgr.

Sherrin Collection. Ravenshoe, N. Queensland.

One male specimen of this rare frog was collected. It differs from typical specimens in having a slightly longer snout, but I hesitate to give it a distinct varietal name on this account. In all other respects it agrees with the type-series, and the characteristic markings are well defined. This species was known only from Celebes.

Hylidæ.

Hyla lesueurii D. & B.

Wilkins Collection. C. Queensland.

A single male of this extraordinary *Hyla* was collected; the species is unlike all the rest in the genus, resembling *Rana agilis* in general appearance.

Œdura tryoni de Vis (ocellata Blgr.).

Sherrin Collection. Two specimens from Ravenshoe, N. Queensland.

* Boulenger, Trans. Zool. Soc. xx. 1914, p. 260, pl. xxix. figs. 4, 4 *a*.
† Boulenger, Ann. Mag. N. H. (6) ii. 1888, p. 142.

VARANUS VARIUS Shaw.

Wilkins Collection. One specimen (skull and dried skin; total length 49": head and body 19" and tail 30").

In this specimen the characteristic yellow spots are absent on the anterior half of the body, which is merely speckled; they are well marked, however, on the posterior half.

VARANUS VARIUS var. BELLI Gray.

Wilkins Collection. Two specimens (skulls and dried skins) of this beautiful banded variety. The Museum had only one specimen. The new pair are 50" (tail 30") and 41" (body 20", tail truncated) respectively. The four dorsal and three caudal bands are arranged as follows:—

The first band is lunate, extending from the head backwards to the shoulders; the second is shaped like a bolero jacket; the third is very broad, with convex borders pointed medially; the fourth covers the sacral region and the upper part of the thighs. There follow three caudal bands, the first 4" wide, the second 8", the third 5"; the tip of the tail is also dark. All the intermediate areas are bright sand-coloured, black speckled.

SCINCIDÆ.

LYGOSOMA (HINULIA) QUOYI D. & B.

Sherrin Collection. Three well-marked specimens from Ravenshoe, N. Queensland.

Although this species has a wide range of distribution, it is rare and local.

LYGOSOMA (HINULIA) TENUE Gray.

Wilkins Collection. One adult collected on Tambourine Mt., S.E. Queensland. This individual is *L. murrayi* Blgr. of the British Museum Catalogue (iii. p. 232). The Museum has only the specimen originally collected by H.M.S. 'Challenger.' On comparing these two specimens of *murrayi*, which have 34 scale-rows, with the series of *tenue* the supposed differences in the size of the ear-opening and in coloration cannot be detected, and without counting the scale-rows it is impossible to tell them apart. *L. tenue* is already known to have scale-rows in 28, 30, or 32 rows, so that it seems impossible to maintain individuals with 34 rows as a distinct species on this character alone. *L. murrayi* Blgr., therefore, should be placed in the synonymy of *L. tenue* Gray.

LYGOSOMA (HINULIA) MONOTROPIS Blgr.

Wilkins Collection. One adult from C. Queensland.

Sandy brown, with ten dark transverse bands on neck and body and twenty-three on the tail. Some of these bands bifurcate on the sides.

LYGOSOMA (LIOLEPISMA) CHALLENGERI Blgr.

This species is only known from the two type-specimens which were received from the 'Challenger' Expedition in 1882. Mr. Sherrin has collected two more in Ravenshoe, both agreeing precisely with ours and with the description in the British Museum Catalogue (vol. iii. p. 268).

LYGOSOMA (RHODONA) PUNCTATOVITTATUM Gthr.

Wilkins Collection. One specimen from Thomby Station, St. George, Central S. Queensland. Until last year we possessed only the type-specimen of this species from Queensland. Prof. Wood-Jones then sent us one collected on Flinders Island in the Great Australian Bight. Zeitz records it from Queensland, Victoria, and Tasmania, so that, although so rare, its range probably extends all over the eastern half of the continent. The present specimen agrees in every particular with the type and with the description in the British Museum Catalogue (iii. p. 335).

LYGOSOMA (HOMOLEPIDA) MJÖBERGI Lönnb. & And.

Sherrin Collection. This species is new to the British Museum. One adult was collected, minus half its tail but otherwise well preserved. It agrees well with Lönnberg and Anderson's description*.

TROPIDOPHORUS QUEENSLANDIÆ de Vis.

Sherrin Collection. This species is also a great rarity new to the Museum's collection. An adult and one very young specimen were obtained which agree well with the minutely detailed description given by de Vis† in everything except markings. They have very pale alternating cross-bands, which give a reticulated effect dorsally and continue on the tail. Beneath, the pale tint predominates, with reticulations on the chin, down the sides and beneath the tail. A median dark wavy band from the chest to the vent. The two specimens are marked exactly alike.

OPHIDIA.

COLUBRIDÆ.

HOPLOCEPHALUS BITORQUATUS Jan.

Wilkins Collection. One young specimen from Thomby Station, near St. George, Central S. Queensland. It has a well-defined cream-coloured nuchal collar and the characteristic black markings on the head. The Museum has not received a specimen of this rare snake since 1876.

ELAPINÆ.

PSEUDECHIS AUSTRALIS Gray.

Wilkins Collection. One chestnut-brown adult from Thomby Station, Central S. Queensland. Aberrant in having 19 scale-rows on the body; 21 on the neck.

* Lönn. & And. Kungl. Sv. Vet.-Akad. Handl. lii. 1915, p. 6.
† Proc. Linn. Soc. N. S. Wales, 1889, vol. iv. p. 1034.

III.—SOUTH AUSTRALIA.

In 1921 Prof. Wood-Jones made a very valuable collection of lizards in Nuyt's Archipelago and the Investigator Group. These lizards, which he presented to the Museum, were mostly rare skinks, amongst them a new species—*Lygosoma* (*Homolepida*) *wood-jonesi*. The description of the latter, with notes on that collection, appear elsewhere *. This year Prof. Wood-Jones has sent us a supplementary collection mostly from the coast of the mainland, including a new *Amphibolurus* and several rare geckos and skinks. Only species of special interest in this second collection will be noted here.

LACERTILIA.

GECKONIDÆ.

HETERONOTA BINOEI Gray.

Whilst working at Prof. Wood-Jones's specimens I compared our series of *H. binoei* and *derbiana* Gray, and came to the conclusion that they cannot be maintained as distinct species. The arrangement of the dorsal tubercles is subject to great individual variation, the *derbiana* form completely intergrading with that proper to *binoei*.

DIPLODACTYLUS TESSELLATUS Gray.

There are but two specimens already in the Museum's collection. Prof. Wood-Jones obtained another on a journey from Hergath Springs, N.E., to Kilalpaninna, Cooper's Creek. Unfortunately all three are males.

PEROPUS VARIEGATUS Dum. et Bibr.

Prof. Wood-Jones's specimens would formerly have been called *Gehyra australis*, but Fry has pointed out † that the genus should be *Peropus* Wiegm., and series of specimens now show that *australis* intergrades with *variegatus*.

AMPHIBOLURUS IMBRICATUS Peters.

Prof. Wood-Jones collected one female at Berri, River Murray. Its scales are extremely lanceolate and the characteristic markings are indistinct. The Museum until now had only two specimens of this very rare species—both females—so that in this case the reverse of the state of things noted under *Diplodactylus tessellatus* has occurred, and we have now three females of *A. imbricatus* and no males, and three males of *D. tessellatus* and no females.

* Procter, "Flora and Fauna of Nuyt's Archipelago and the Investigator Group. No. 5—Lizards." Trans. Roy. Soc. S. Australia, 1923.

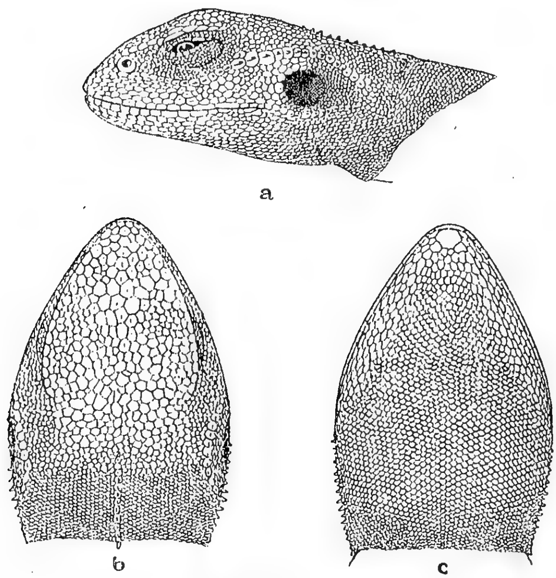
† Fry, Rec. W. Aust. Mus. i. 1914, p. 178.

Amphibolurus fionni, sp. n.

Habit slender, limbs very long.

Head moderate; snout as long as the orbit, with strongly-marked canthus rostralis and concave loreal region; nostril nearer the eye than tip of snout, situated below the canthus edge; tympanum as large as eye-opening; upper head-scales tubercular, keeled on the snout, smallest on the supraocular region. Sides of neck strongly plicate; a fold set with small spines from the angle of the mouth to the shoulder, others below the eye and above the tympanum, and one in the form of a low nuchal

Text-figure 4.



Head of *Amphibolurus fionni*, sp. n.
a. lateral view; *b.* dorsal view; *c.* ventral view.

crest, flanked by a pair reaching from the occiput to the shoulders. Gular scales minute. Body covered with small keeled scales, which are minute on the sides and enlarged on the vertebral region. No enlarged ones scattered on the sides. Ventral scales small, smooth, the ones under the fore-arm and under the tibia keeled. Caudal scales small, strongly keeled.

Limbs very long, the fourth toe reaching to the nostril when the hind-limb is adpressed, scales on the limbs slightly enlarged, strongly keeled. Digits long, distinctly fringed. About 40 femoral pores, slightly interrupted in the middle. Tail slender; depressed at the base; twice length of head and body.

Upper surfaces all olive-grey with darker variation. A lateral series of large dark blotches. Greyish white beneath, the throat reticulated with grey.

Described from a single female. Head and body 60 mm. in length; tail 118 mm.

This species is allied to *A. ornatus* Gray, from W. Australia, from which it may easily be distinguished as follows:—

A. ornatus Gray.	*A. fionni*, sp. n.
Lateral scales heterogeneous.	Lateral scales homogeneous.
No nuchal crest or spinose folds on head and neck (described from an adult male).	A low nuchal crest and several lateral spinose folds on neck (although described from a small female).
Toes feebly fringed.	Toes strongly fringed.

Since the type is a small female the spinose folds make a distinguishing character, as we know that adult males in *ornatus* do not have them, and it is to be expected that the male of the new species would have them still more developed. The coloration and markings are also quite distinctive, but this might be sexual.

It is also allied to *A. rufescens* Stirling, but the characters in which it differs from this are more numerous.

Amphibolurus adelaidensis Gray.

Prof. Wood-Jones caught three specimens of this beautifully-marked species, which has not been received here for the past fifty years.

Tympanocryptis cephalus Gthr.

Zeitz in his Catalogue (p. 198) places this species in the synonymy of *T. lineatus* Peters. The two species are, however, quite distinct; *lineatus* has sharply-keeled scales and spinose tubercles; *cephalus* has smooth, more cycloid scales and less spinose tubercles. The present collection included a female and young.

Lygosoma (Liolepisma) entrecasteauxii D. & B.

The adult collected by Prof. Wood-Jones is the first to be added to the Museum's collection since the publication of the Catalogue in 1887. As far as I am aware, it has so far only been recorded from Tasmania. The present specimen was caught on Pearson's Island, Investigator Group.

The new specimen has tricarinate dorsal scales, and is exceptionally well marked.

Lygosoma (Rhodona) bougainvillii Gray.

One adult was collected at Port Lincoln.

Lygosoma (Rhodona) bipes Fischer.

This species is very rarely met with in South Australia.

Ablepharus lineo-ocellatus var. adelaidensis Peters.

One adult of this rare variety from Port Lincoln.

OPHIDIA.

Elapinæ.

Diemenia textilis D. & B.

Kreft states that young specimens from Adelaide lack the typical dorsal bands met with in young from elsewhere. A specimen in the present collection from Mt. Lofty bears this out, but it is well worth noting that there is a specimen from N. Queensland in the Museum's collection which is precisely similar in this respect.

54. On Additions to the Snake Fauna of Egypt.

By Major S. S. FLOWER, O.B.E., F.L.S., F.Z.S.

[Received August 31, 1923 : Read November 6, 1923.]

1. *Summary.*—Snakes of the genera *Typhlops* and *Lycophidium* are recorded for the first time from Egypt, remarks are made on the status of *Lycophidium abyssinicus*, and the Proteroglyph Snake *Walterinnesia ægyptia* is for the first time definitely proved to be an inhabitant of Egypt.

2. *Acknowledgements.*—I am indebted to Dr. Walter Francis Innes Bey, formerly Curator of the Zoological Museum, School of Medicine, Cairo, to Prof. Edward Hindle, F.L.S., F.Z.S., Biological Department, School of Medicine, Cairo, and to Mr. Michael J. Nicoll, F.Z.S., Assistant Director, Egyptian Government Zoological Service, for kindly giving me many opportunities of examining Egyptian snakes.

I wish also to express my thanks to Miss J. B. Procter, F.L.S., F.Z.S., for her kindness in looking up, and allowing me to examine, certain snakes in the collection under her charge in the British Museum.

3. *Typhlops.*

When Mr. Boulenger published his "List of the Snakes of North Africa," P. Z. S. 1919, p. 299 *et seq.*, no representatives of the family Typhlopidæ were known from Egypt.

Among snakes lent to me for examination in April 1923 were two individuals of the genus *Typhlops*.

1*st*. A spirit specimen definitely proves that *Typhlops* occurs in Egypt. The discovery is due to Dr. Innes, who caught the snake himself on 6th March, 1906, among the roots of a tamarisk tree at Marg, on the eastern outskirts of Cairo.

The dimensions of this specimen in spirit, 17th April, 1923, were :—

	mm.	per cent.	Remarks.
Length, snout to vent	267	100	Scales in 22 or 24 rows.
„ tail	4	1·49	Tail ends in a sharp point.
„ total	271	101·49	
Diameter of body	5	1·87	Goes 54 times in total length.
„ tail, at vent	5	1·87	
Head { length of shielded portion, in median line }	4	1·49	
„ total length	7 (?)	2·62 (?)	
„ width	4·5	1·68	
„ depth	4	1·49	

This individual appears to me referable to the *Typhlops vermicularis* of Mr. Boulenger's British Museum Catalogue of Snakes, and so extends the range of that well-known species.

2*nd*. On the 15th of April, 1923, Prof. Hindle sent me a live snake which he had purchased in Cairo from an Arab vendor of reptiles. The Arab said the snake came from Damietta. This may or may not have been so. As Damietta is a seaport its trade with other parts of the Mediterranean and the local habit of careening sailing craft on the shore make it possible for a snake found there to have been brought, by accident, with cargo or ballast from almost anywhere. Seaports are not "good localities" for recording reptiles from.

As far as I could examine this live individual it was also a specimen of *Typhlops vermicularis*, but it was of most unusual size for that species, being about 383 mm. in total length. The diameter of body was 7 mm. (*i. e.*, goes about 53 times in total length).

4. *Lycophidium*.

In "A List of the Snakes of North-East Africa" by Mr. Boulenger, P. Z. S. 1915, p. 646, two species of *Lycophidium* are mentioned:—

Lycophidium capense from "Tropical and South Africa."
Lycophidium abyssinicus from "Abyssinia."

In "A List of the Snakes of North Africa" by the same author, P. Z. S. 1919, the genus *Lycophidium* is not mentioned.

5. *Lycophidium abyssinicus* Boulenger, Brit. Mus. Cat. Snakes, i. p. 342, appears to be known only from the type-specimen in the British Museum, and to differ from *L. capense* only in having the rostral shield narrowed, almost pointed, behind. On examining the type in London, July 17, 1923, it appears to be inseparable from *L. capense*. Two females of *L. capense* from the Blue Nile have their rostral shields pointed.

6. *Lycophidium capense*.

When Mr. Boulenger wrote the Catalogue of Snakes there were no specimens of *L. capense* from North-East Africa in the British Museum, and so the single individual *Lycophidium* from Abyssinia was separated by a very wide tract of country from the known range of *L. capense*.

In July 1923 in the British Museum there were four specimens from North-East Africa entered in the catalogue in manuscript by Mr. Boulenger, under:—

Lycophidium capense, var. B.

Female.	V. 188. C. 31.	Roseires, Blue Nile.	S. S. Flower.	1909.
Female.	V. 191. C. 40.	Deesa, „	„	„
Male.	V. 166. C. 35.	Onaramalka, Abyssinia.	G. A. F. Abercromby.	1910.
Female.	V. 180. C. 33.	„ „	„	„

These four specimens have *all* subcaudal shields paired.

7. An Egyptian *Lycophidium*.

Dr. Innes told me that he had in spirit a supposed young individual of *Walterinnesia ægyptia*, collected in agricultural land in the Fayûm, Upper Egypt, in 1904, by the Rev. Father Teillard, and that there was no doubt whatsoever as to the locality. In answer to my enquiries Dr. Innes told me that Father Teillard had never collected in the Sudan, but had, from Cairo, gone to stay at a farm in the Fayûm, and while there came across this snake and brought it back with him for Dr. Innes's collection.

On 19th April, 1923, Dr. Innes lent me this specimen for identification. For fear of damaging it, I did not examine the teeth, but externally there appears no reason not to consider it a *Lycophidium capense*.

Scales 17 rows. Ventrals *circa* 196. Subcaudals 39: these subcaudals consist of three pairs at base, then three undivided scales, then thirty-two pairs.

It was on the strength of these undivided subcaudals that the snake had been referred to *Walterinnesia*.

It is a most remarkable fact that this South and Tropical African snake should occur in the Fayûm, but a parallel case appears to exist in the Rough-keeled, or Egg-eating, Snake *Dasypeltis scabra*, of which the late Dr. John Anderson recorded a single specimen from the Fayûm.

8. *Walterinnesia ægyptia* Lataste, 1887.

Dr. Innes discovered this species: he saw a snake in the hands of a native "snake-charmer" in Cairo, and recognizing that it was something different from the ordinary Cobras of the genus *Naia*, purchased the specimen and sent it to France to Monsieur Fernand Lataste.

On 7th February, 1887, this snake was described as a new genus and species by M. Lataste ('Le Naturaliste,' Paris, 1887, p. 411 *et seq.*), the generic name being in honour of the discoverer.

9. "*Habitat*" of *Walterinnesia*.

As the type-specimen was purchased by Dr. Innes from a professional "snake-charmer" in Cairo, it was in itself no evidence of being of Egyptian origin. A trade in live reptiles between the resident and wandering performers in Asia and North Africa exists, and probably has existed for many centuries.

Subsequently Dr. Innes purchased two more individuals from the same man. So three specimens of *Walterinnesia* appear to have been known when Dr. John Anderson wrote on the herpetology of Egypt, but Dr. Anderson does not mention the number.

Dr. Anderson wrote ('Zoology of Egypt,' Reptilia, 1898, p. 325): "The only specimens on record of this species were purchased by Dr. Walter Innes from a snake-charmer in Cairo, and there is nothing to fall back upon, beyond the statement of the juggler, to establish it (*Walterinnesia*) as an Egyptian species. I have made the most careful enquiries about its presence in the neighbourhood of Cairo, without having been able to throw any light upon the subject, and Dr. Innes's endeavours to procure more specimens have been fruitless."

Since Dr. Anderson's time several other visitors to Egypt, interested in Zoology, have made special endeavours to obtain specimens of *Walterinnesia*, but without success.

On 12th November, 1908, the man who had sold the first specimens to Dr. Innes brought to Giza a live *Walterinnesia*, which I purchased for the Giza Zoological Gardens. This man said that this species of snake was not found in Egypt, and could only be obtained near the river Atbara, in the Berber Province of the Sudan. This statement was probably made to enhance the value of the specimen he offered to sell, but it influenced me at the time. I informed Mr. Boulenger, and in G. Z. G. "List of Animals (2nd edition)," 1910, p. 328, wrote of this species "*Habitat* probably Upper Nubia." So Mr. Boulenger, P. Z. S. 1915, p. 656, gave the distribution of *Walterinnesia ægyptia* as "Nubia? Egypt?" and, P. Z. S. 1919, p. 306:—"Egypt? Nubia?"

Meanwhile, in 1904, Dr. Innes had received from the Fayûm a black snake supposed to be an immature *Walterinnesia*. In April 1923 I had an opportunity of seeing this specimen, and, as mentioned above, it belongs to a very different genus.

10. Rediscovery of *Walterinnesia*.

On 5th April, 1923, Mr. M. J. Nicoll shot a black snake about 21 miles east of Cairo, on the Cairo-Suez road, which he handed over to me the same day for examination. It is the fifth individual of *Walterinnesia ægyptia* of which we have record, and of great importance as being the first specimen obtained with reliable data as to locality, etc. It proves that M. Lataste was not in error when he gave the specific name *ægyptia*. Mr. Nicoll's find also brings to notice the interesting fact that *Walterinnesia* is found in the desert, far from water, in the same kind of country where the Vipers of the genera *Cerastes* and *Echis* occur.

The only Proteroglyph Snakes, besides *Walterinnesia*, which are known from Egypt are two species of Cobra, *Naia haie* and *Naia nigricollis*, neither of which, as far as my present experience goes, are ever found more than about half a mile's distance from permanent water.

11. Known specimens of *Walterinnesia*.

(i.) The type. Female. Described by Lataste. Now in British Museum.

(ii.) Male. Described by Boulenger (Cat. Snakes, iii. p. 392) and by Anderson (1898, pp. 324. 325). Now in British Museum.

(iii.) Obtained by Dr. Innes (as were Nos. i. and ii.). Was in the Cairo School of Medicine Museum, now in the Giza Zoological Museum.

(iv.) Obtained alive (*v. sup.*) November 12, 1908, lived in Giza Zoological Gardens for eight months nineteen days. Male. Now in the British Museum.

(v.) Male. Collected by Mr. M. J. Nicoll, April 5, 1923, on desert, about 21 miles east of Cairo. Now in Giza Zoological Museum.

12. Notes on 5th specimen of *Walterinnesia ægyptia*, by S. S. F., April 5, 1923.

Male. Collected to-day by Mr. Nicoll.

General impression:—A heavily built, short-tailed snake, with a large flattish head, a small black eye, and a conspicuously large nostril.

Colour:—Upper surfaces shiny black; lower surfaces grey.

Ventrals 190. Anals 2. Subcaudals 51 (actually 51 right, 50 left. First, at base, divided. Second to sixth entire. Seventh divided. Eighth entire. Remaining forty-two divided, and one extra half on right side).

	mm.	per cent.	Remarks.
Length, snout to vent	843	100	
" tail	143	16·9	Tail ends in a sharp point.
" total	986	116·9	
Diameter (greatest), body	*c.* 23	*c.* 2·72	
Head { length of shielded portion, in median line }	24	2·84	{ Head-shields agree with description by Mr. Boulenger, Cat. Snakes, iii. p. 392.
" total length	32	3·79	
" width	23	2·72	
" depth	13	1·54	

Number of scales round body:—

At about	5th	ventral	*circa* 29
"	20th	"	21
"	25th	"	21
"	50th	"	23
"	75th	"	23
"	100th	"	23
"	125th	"	21
"	150th	"	19
"	175th	"	17

55. Cervical Vertebræ of a Gigantic Blue Whale from Panama. By Sir SIDNEY F. HARMER, K.B.E., Sc.D., V.P.R.S., F.Z.S.

[Received November 19, 1923; Read November 20, 1923.]

(Text-figure 1.)

The bones under consideration (which were exhibited) were the second and third cervical vertebræ of a Blue Whale (*Balænoptera musculus* L.), and had been presented to the British Museum (Natural History) by Mr. F. A. Mitchell-Hedges, who had given the following account of their history:—The whale entered the harbour at Cristobal, the northern entrance to the Panama Canal, in January 1922. It passed up the canal towards the first locks at Gatun, and having become a menace to shipping, it was killed with machine-guns. It was towed by tugs to the Cristobal docks, where unsuccessful efforts to raise it from the water were made with powerful 75-ton cranes. It is said to have been carefully measured, at this stage, as having a length of 98 feet, and its weight was estimated at 100 tons. It was later towed out to sea, but it drifted ashore again, and after having been towed out once more, it was bombed from the air by United States army planes. Parts of the carcass subsequently came ashore at Santa Isabel, between Nombre de Dios and Cape San Blas, where the vertebræ were found by Mr. Mitchell-Hedges.

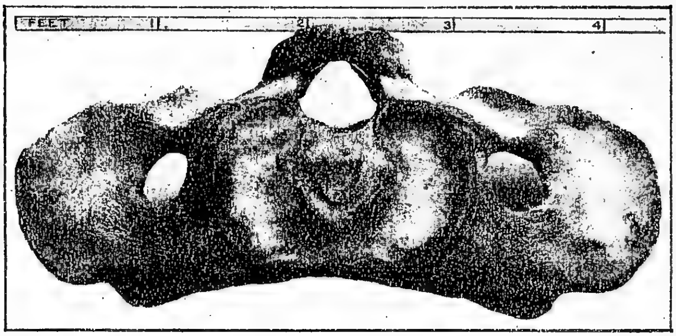
The specimen is of special interest from several points of view. The Blue Whale is commonly considered an ice-loving species, and it has been found in large numbers on the fringe of the Arctic and Antarctic ice. Although it is known to travel considerable distances from the poles, as shown by its frequent capture by whaling companies off the Finmark, Newfoundland, and South African coasts, records of its occurrence in or near the Tropics are rare. In his memoir, "The Whalebone Whales of New England"*, Mr. Glover M. Allen states that the Blue Whale is essentially a "cold-water" species, and that New Jersey "perhaps represents nearly the normal southward limit" on the Atlantic coast, though it may eventually be found to follow the inshore waters as far south as the Carolina coast. The specimen under consideration occurred in lat. 9° 30′ N., and the record is of importance as bearing on the possibility of a migration across the equator of Blue Whales from the Northern Hemisphere to the Southern, or *vice versâ*.

* Allen, G. M., Mem. Boston Soc. Nat. Hist. vol. viii. No. 2, p. 255 (1916).

In structure the vertebræ show an unusual peculiarity. Although *Balænoptera* is ordinarily distinguished from *Balæna* by the fact that all the cervical vertebræ are completely free, these two vertebræ are firmly ankylosed to one another by a union between their centra, principally on the right side, at the periphery, where there is some indication of a diseased condition of the bone.

The specimen is further of interest, from the information it gives as to the size which may be reached by the Blue Whale in Northern waters. Recent unpublished records of the Southern Whaling Companies establish the fact that the length of 100 feet may be exceeded in that part of the world, and the opinion has been expressed that the Southern race differs from the Northern by attaining a greater size. Thus Allen (*op. cit.* p. 249), relying on measurements of Northern Blue Whales made by

Text-figure 1.



Blue Whale (*Balænoptera musculus*). Anterior view of the ankylosed axis and third cervical vertebra; the neural arch of the latter just visible through the neural canal of the axis. Panama, F. A. Mitchell-Hedges Coll.

A scale nearly of 5 feet in length is seen resting on the somewhat injured neural spine of the axis.

True and at the Norwegian whaling stations, comes to the conclusion that 77 feet 2 inches "is probably nearly a true maximum," although he mentions a Norwegian record of 87 feet 6·5 inches. The question had previously been discussed at length by True *, who concluded (p. 156) that the maximum length of Newfoundland Blue Whales is less than that of Norwegian specimens, pointing to a difference in size of Blue Whales on opposite sides of the Atlantic. This opinion, which has been quoted in support of the view that the Eastern and Western schools are distinct in that ocean, is obviously affected by the present record.

* True, F. W., "Whalebone Whales of the Western North Atlantic," Smithson. Contr. Knowledge, vol. xxxiii. (1904).

The material available for comparison in the British Museum is unfortunately scanty, and the best is a skeleton of a Blue Whale which was stranded at Rosslare, Wexford Bay, on Mar. 25, 1891. According to the information given by W. Crouch * and G. E. H. Barrett-Hamilton †, this specimen was probably a female 82 feet long. The examination of its vertebral column shows that the epiphyses of the centra are free, or nearly free, along the whole length of the column. The process may perhaps have commenced in the caudal region. It should be noted, however, that True ‡ quotes an observation by Guldberg, who measured a male Blue Whale as 78 feet 9 inches long, and subsequently ascertained that all the epiphyses were ankylosed to the bodies of the vertebræ. Flower § has pointed out that ankylosis of the vertebral epiphyses in Cetacea commences in the cervical and caudal regions, extending from both ends towards the middle of the length of the column, where the process is finally completed. He distinguishes animals in which this process has commenced but is incomplete as being in the "adolescent" stage, which has thus hardly been reached by the Wexford whale. The Panama vertebræ, on the contrary, have their epiphyses completely united; and it may be inferred from their condition that the animal was fully adult, although it is obvious that they give no complete answer to the question whether all the vertebral epiphyses were thus united.

The axis of the Panama specimen measures 4 feet 7¼ inches from tip to tip of the transverse processes, and it thus greatly exceeds in size those of (1) the Wexford whale, with a corresponding measurement of 3 feet 8½ inches, and (2) the female specimen recorded by Sir William Turner ‖, of an estimated length of "70 to 80 feet or upwards," stranded at Longniddry, Firth of Forth, November 1869, whose axis measured 3 feet 8 inches across. The Panama axis is strikingly more massive than that of the Wexford whale, as is shown by a comparison of the weights. The ankylosed axis and third cervical vertebra of the Panama whale weigh 112 lbs., while the corresponding bones of the Wexford whale are only 53 lbs. This gives a fair comparison of the actual volume of the bones, even taking into account the possibility of a slight error due to differences in the amount of animal matter left after cleaning. It is further in accordance with expectation, in an animal increasing from 80 to 100 feet in length, a proportion of 4 to 5. The increase in volume should be in proportion to the cubes of these numbers, and the cube of 5 is almost exactly twice the cube of 4.

It is of interest to attempt to verify the recorded length of the Panama whale. True ¶ has recorded the measurements of a

* 'The Zoologist,' 1891, p. 215.
† *Ibid.* p. 306.
‡ *Op. cit.* p. 151.
§ Proc. Zool. Soc. 1864, p. 385.
‖ 'Marine Mammals Anatom. Mus. Univ. Edinburgh,' London, 1912, pp. 40–50.
¶ *Op. cit.* pp. 180, 184.

Blue Whale stranded at Ocean City, New Jersey, in October 1891. Although not completely satisfactory, in view of the small size of the animal, this may be taken as a basis for comparison. The measurements it is necessary to notice are as follows:—

	Whale, length.	Skull, length.	Mandible, along curve.	Mandible, straight.	Axis width.
New Jersey ...	66′ 2″	14′ 7½″ (estimated)	17′ 1″	15′ 2″	3′ 0″
Wexford	82′ 0″	?	20′ 1″	18′ 8″	3′ 8½″
Longniddry ...	?	—	21′ 2″	19′ 5″	3′ 8″
Panama	—	—	—	—	4′ 7¼″

The Wexford skull is partially disarticulated, and it is not possible to state its exact length. According to True's measurements of the New Jersey specimen, the total length of the animal is approximately given by multiplying the length of the skull by 4·5, of the mandible (along curve) by 3·9, of the mandible (straight) by 4·4, and of the axis-breadth by 22. The proportions in other whales are known to differ as a result of age or individual variation, but it is not without interest to ascertain how far the factors indicated above will apply in the present connection. Taking these proportions, the estimates of the length of the Longniddry whale, derived from the axis, the mandible (straight) and the mandible (along curve) are respectively 80′ 8″, 85′ 5″, and 82′ 6″, with an average of 82′ 10″, which agrees well enough with Turner's vague estimate of "70 to 80 feet or upwards." The same three measurements of the Wexford whale are respectively 81′ 7″, 82′ 1″, and 78′ 4″, with an average of 80′ 8″, as compared with the recorded length of 82 feet. The only available measurement of the Panama whale is that of the axis; but, applying the same proportion, the estimated total length of the animal is 101′ 3½″. I think this may be regarded as a substantial confirmation of the recorded length of 98 feet. The skull of this animal may have been about 23 feet long.

Scoresby*, a particularly reliable authority, mentions the following records of large Blue Whales, which he describes as *Balænoptera Gibbar*:—A specimen found dead in Davis Strait, 105 feet; an individual stranded on the banks of the Humber in September 1750, 101 feet. Another old record of a large Blue Whale is that of the well-known "Ostende Whale," which was found floating in the North Sea and towed into the harbour of Ostende on Nov. 4, 1827, its length having been variously estimated as 80 to 102 feet. It has been customary to discredit such measurements, but the evidence of the Panama specimen tends to confirm their accuracy. The point is one of great importance, in view of the inclination of naturalists to distinguish a

* 'An Account of the Arctic Regions,' vol. i. pp. 481, 482 (1820).

Southern race of Blue Whales by their superior size. The evidence now submitted shows that Blue Whales of a size much larger than that generally accepted may occur to the north of the equator, and thus throws doubt on the assumption that the Northern Blue Whale is smaller than those that frequent the Southern Ocean. It may be suggested that owing to the great intensity of whaling which has occurred in Northern waters, few Blue Whales of the largest size have been permitted to survive, but that in the South, where whaling has been practised only since 1904/5, a greater number of these individuals have remained. It may be anticipated that the enormous destruction which is at present taking place in the South will result in a diminution of the number of these very large specimens.

56. Notes on the African Crested Rat (*Lophiomys imhausi*). By G. H. Goldfinch.*

[Received July 9, 1923: Read November 6, 1923.]

Native (Wandorobo) name "Monget" or "Ermonget."

The first one of these animals I got was when I was stationed at Nakuru; it came from the Aberdare side. It was taken out of a hole in a tree by a Wandorobo whom I had sent to collect a hyrax. I found that the Wandorobo had the superstition about this animal that if anybody got bitten by it he died. I think this may be taken to mean that somebody got bitten and got blood poisoning and died, as their bite is harmless. However, after this old man found he was unhurt, I had no difficulty in getting all I wanted, and at one time I had something like a dozen of them. I forget whether I had one born in captivity, but I remember one delightful toto. With regard to food, I have come to the conclusion that besides eating leaves etc. they probably also want, or rather eat, insects, small mammals, young birds, etc. I used to feed mine on sweet potato leaves mainly, but found they would also eat lucerne, wild clover, etc., and would eat the potatoes themselves, but did not seem to care much about them. On this diet I have had them live six months, as far as I can remember. Why I think they are also carnivorous is this: I kept them in a sort of aviary with a row of boxes for them to go into, and I had got hold of a winged Guinea pigeon and thought it would be a good place for him, but in the morning all that remained were a few feathers. They are, I think, purely nocturnal animals, but run about much more on the ground than tree-hyrax. They are most cunning in escaping from cages. I have met mine, when they got out, trotting along the road to Nakuru in the middle of the night. I gave two or three to the late C. W. Woodhouse to try and get home to the Zoo, but they died on the voyage. I daresay what troubles them is the heat, as they come from the cold forests. I think they are pretty hardy really, and there seems to be no bother about getting them to feed when they are freshly caught. Mine used to come out of their boxes just as it began to get dark. The best method of handling them is by the tail. There would, I think, be no difficulty in getting them if they were wanted. This, by the way, is not the animal that gnaws old tusks of ivory, as Sir F. Jackson suggested. What does that is the porcupine.

* Communicated by the Secretary.

EXHIBITIONS AND NOTICES.

October 23rd, 1923.

Dr. A. Smith Woodward, F.R.S., Vice-President, in the Chair.

The Secretary read the following Report on the Additions made to the Society's Menagerie during the months of June, July, August, and September, 1923:—

June.

The registered additions to the Society's Menagerie during the month of June were 210 in number. Of these 91 were acquired by presentation, 13 were deposited, 69 were purchased, and 37 were born in the Menagerie.

The following may be specially mentioned:—

1 Chimpanzee (*Anthropopithecus troglodytes*), ♀, from West Africa, purchased on June 12th.

1 Black Mangabey (*Cercocebus aterrimus*), ♂, from the Congo, purchased on June 29th.

2 Pumas (*Felis concolor*), ♂ ♀, from South America, purchased on June 22nd.

1 Goliath Heron (*Ardea goliath*), from Kerna Marshes, Mesopotamia, presented by Major Wilson.

2 Kurdistan Chukar Partridges (*Alectoris græca kurdistanicus*), from Kurdistan, new to the Collection, presented by Dr. Sinderson on June 8th.

1 Syrian Ostrich (*Struthio camelus syriacus*), from Jauf, Central Arabia, new to the Collection, presented by Sir Percy Cox, G.C.M.G., and Capt. R. E. Cheesman, I.A., on June 8th.

2 Sundevall's Lizards (*Lygosoma sundevalli*), new to the Collection, from Dodoma, E. Africa, presented by Arthur Loveridge, C.M.Z.S.

July.

The registered additions to the Society's Menagerie during the month of July were 316 in number. Of these 148 were acquired by presentation, 146 were deposited, 9 were purchased, 8 were received in exchange, and 5 were born in the Menagerie.

The following may be specially mentioned:—

A collection of animals from Australia, containing Opossums, Bandicoots, Regent-Birds, Bower-Birds, Brush-Turkeys, and others, presented by the Marquess of Tavistock, F.Z.S., on July 3rd.

A collection of animals from Gambia, containing an Ostrich, a Porcupine, an African Tantalus, Owls, and others, presented by H.E. Capt. C. H. Armitage, C.M.G., D.S.O., F.Z.S., on July 24th.

1 Llama (*Lama glama*), bred in the Menagerie on July 7th.

A collection of Indian Snakes, including an Indian Sand-Snake (*Zamenis arenarius*) and a Hodgson's Snake (*Coluber hodgsoni*), both new to the Collection, presented by A. A. L. Flynn, Esq., C.M.Z.S., on July 26th.

August.

The registered additions to the Society's Menagerie during the month of August were 205 in number. Of these 58 were acquired by presentation, 78 were deposited, 5 were purchased, 2 were received in exchange, and 62 were born in the Menagerie.

The following may be specially mentioned:—

1 South African Giraffe (*Giraffa camelopardalis capensis*), purchased on August 21st.

2 Ocelots (*Felis pardalis*), 1 Hensel's Cat (*Felis pardinoides*), 2 Crab-eating Dogs (*Canis thous*), and 2 Amazonian Skunks (*Mephitis amazonicus*), the last new to the Collection, from Brazil, presented by George Chalmers, C.M.Z.S., on August 9th.

2 Gelada Baboons (*Theropithecus gelada*), from Abyssinia, received in exchange on August 30th.

1 Black Howler (*Mycetes caraya*), from the Amazons, presented by Walter Goodfellow, F.Z.S., on August 21st.

1 Puma (*Felis concolor*), from South America, presented by Arthur R. T. Woods on August 15th.

1 Fossa (*Cryptoprocta ferox*), from Madagascar, presented by Percivale Helyar on August 11th.

6 Lion Cubs (*Felis leo*), born in the Menagerie, 2 on August 1st and 4 on August 25th.

September.

The registered additions to the Society's Menagerie during the month of September were 221 in number. Of these 135 were acquired by presentation, 60 were deposited, 18 were purchased, 5 were received in exchange, and 3 were born in the Menagerie.

The following may be specially mentioned:—

1 African Elephant (*Loxodon africanus*), from Tanganyika Territory, presented by H.E. Sir Horace Byatt, K.C.M.G., Honorary Member of the Society, on September 14th.

2 Great Anteaters (*Myrmecophaga jubata*), from South America, purchased on September 15th.

1 Yellow-throated Marten (*Martes flavigula*), from India, presented by the Bombay Natural History Society on September 12th.

Dr. C. W. ANDREWS, F.R.S., F.Z.S., exhibited, and made some remarks upon, an imperfect phalangeal bone belonging to one of the curious clawed Perissodactyls, the Ancylopoda (*Chalicotheroidea*). Although only a scrap of bone, it is quite characteristic, and there is no doubt about the determination. The interest of the specimen lies in the fact that this is the first recorded occurrence of the group in Africa: members of it are known from Europe, Asia, and America in beds of ages ranging from the Eocene up to the late Pliocene or early Pleistocene, the Pleistocene forms being confined to Asia. The beds from which the present specimen comes are of late Pliocene or, more probably, Pleistocene age, and are situated on the Bunyoro side of Lake Albert: remains of *Hippopotamus phacochœrus*, Crocodile, and fish were also found. It is interesting to note that a species of Chalicotherium is found in the Pliocene beds of Samos associated with Samotherium, a close relative of the existing Okapi, and it may be suggested that possibly a still surviving Chalicothere may be the basis of the persistent rumours of the existence in Central Africa of a large Bear or Hyæna-like animal. The specimens were collected and sent to the British Museum by Dr. Wayland, Director of the Geological Survey of Uganda.

Mr. D. SETH-SMITH, Curator of Mammals and Birds, exhibited a series of lantern-slides of Lion-cubs born in the Society's Gardens. He said that since 1887 no lion-cubs born in the Gardens had lived more than a very short time. At the present time there were two families of cubs, one of two and the other of four, the former being over three months and the latter about nine weeks old. Both families had been born and were being reared in the outside cages of the Lion House, and at present appeared to be thriving.

Mr. SETH-SMITH also exhibited a living specimen of the Mangabey described in 1899 by Dr. Sclater as *Cercocebus congicus* (P. Z. S. 1889, p. 827), and pointed out that it was without doubt a semi-albino variety of *Cercocebus aterrimus*.

Dr. CARL ABSOLON exhibited a large series of drawings and photographs of Cave Animals from the Balkans.

Mr. E. A. SPAUL, B.Sc., F.Z.S., gave an account of his experiments on acceleration of metamorphoses of Frog-tadpoles by injection of anterior-lobe pituitary-gland extract and iodine.

November 6th, 1923.

Sir S. F. Harmer, K.B.E., F.R.S., Vice-President, in the Chair.

The Secretary exhibited, and made remarks upon, a photograph of a Ratel from Lake Magadi, Kenya.

Mr. D. Seth-Smith, F.Z.S., Curator of Mammals and Birds, exhibited a living specimen, believed to be about six months old, of the Pigmy Hippopotamus (*Chœropsis liberiensis*) which had been purchased by the Society from Mr. Harry Smith, of Monrovia, and arrived on November 2nd. Its weight on arrival was 40 lbs., its length 24 inches, and height 14 inches. It was fed entirely upon milk, and appeared to be in excellent condition. Since its arrival in the Society's Gardens it had spent most of the daytime asleep in its box, taking to the warmed water of the tank towards evening. Although so young it proved to be an excellent swimmer.

Text-figure 1.

Baby Pigmy Hippopotamus (*Chœropsis liberiensis*).

Great credit was due to Mr. Harry Smith for having so successfully reared this little animal since it was but a few weeks old, and to Mr. R. M. Mitchell, chief officer of the s.s. 'Melville,' who carefully tended it on the voyage home.

Mr. F. A. Mitchell-Hedges, F.Z.S., F.L.S., F.R.G.S., gave an account of his recent expedition through the jungle-region of Panama, and illustrated his remarks with a series of lantern-slides of scenery, natives, and large fish.

November 20th, 1923.

Dr. A. SMITH-WOODWARD, F.R.S., Vice-President,
in the Chair.

The SECRETARY read the following Report on the Additions made to the Society's Menagerie during the month of October, 1923:—

The registered additions to the Society's Menagerie during the month of October were 219 in number. Of these 50 were acquired by presentation, 26 were deposited, 29 were purchased, and 114 were born in the Menagerie.

The following may be specially mentioned:—

1 Puma (*Felis concolor*), from Bolivia, presented by Mr. Robert Macdonald on October 20th.

1 Jaguar (*Felis onca*), from Parnahyba, Brazil, presented by Mr. Louis F. Hamley on October 16th.

1 Serval (*Felis serval*), from Sierra Leone, presented by Capt. F. R. Ellis on October 22nd.

The SECRETARY exhibited, and made remarks upon, a collection of Autographs recently presented to the Society by Mr. Hugh S. Gladstone, F.Z.S.

Mr. R. T. GUNTHER, M.A., F.Z.S., exhibited, and made remarks upon, (1) Vertebræ of Mesozoic Crocodile showing the course of intercostal arteries, and (2) a Jaw-bone of *Ursus anglicus* Gunther, from the Cherwell Gravels.

No. 244.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

October 23rd, 1923.

Dr. A. Smith Woodward, F.R.S., Vice-President, in the Chair.

The Secretary read a report on the Additions made to the Society's Menagerie during the months of June, July, August, and September, 1923.

Dr. C. W. Andrewes, F.R.S., F.Z.S., exhibited, and made remarks upon, an imperfect phalangeal bone belonging to one of the curious clawed Perissodactyls, the Ancylopoda (Chalicotheroidea).

Mr. D. Seth-Smith, F.Z.S., exhibited, and made remarks upon, a series of photographs of Lion cubs recently born in the Society's Menagerie. Mr. Seth-Smith also exhibited some rare varieties of the Black Mangabey Monkey, *Cercocebus aterrimus*.

Dr. Carl Absolon exhibited a large series of drawings and photographs of Cave Animals from the Balkans.

Mr. E. A. Spaul, B.Sc., F.Z.S., gave a *résumé* of his experiments on acceleration of metamorphoses of Frog-Tadpoles by injection of Anterior-lobe Pituitary-gland Extract and Iodine.

A paper on "Observations on the Development of the Sympathetic Nervous System and Suprarenal Bodies in the Sparrow," by A. Subba Rau, B.A., M.Sc., and P. H. Johnson, B.Sc., F.Z.S., was communicated by Mr. A. Subba Rau.

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* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

In the absence of the Authors, the following papers were taken as read:—H. C. Abraham, F.Z.S., "A new Spider of the Genus *Liphistius* from the Malay Peninsula, and some Observations on its Habits"; Malcolm A. Smith, M.R.C.S., L.R.C.P., F.Z.S., "A Review of the Lizards of the Genus *Tropidophorus* on the Asiatic Mainland"; J. G. H. Frew, M.Sc., F.Z.S., "On the Larval Anatomy of the Gout-fly (*Chlorops tæniopus* Meig.) and two related Acalyptrate Muscids with Notes on their Winter Host-plants"; Arthur Loveridge, F.E.S., C.M.Z.S., "(1) Notes on Mammals collected in Tanganyika Territory, 1920–1923," and "(2) A List of the Lizards of British East Africa (Uganda, Kenya Colony, Tanganyika Territory, and Zanzibar) with Keys for the Diagnosis of the Species."

The next Meeting of the Society for Scientific Business will be held on Tuesday, November 6th, 1923, at 5.30 P.M., when the following Communications will be made:—

F. A. Mitchell-Hedges, F.Z.S., F.L.S., F.R.G.S.

The Primeval Jungle of Panama.

G. H. Goldfinch.

Notes on the African Crested Rat (*Lophiomys imhausi*).

Harold G. Jackson, F.Z.S.

A Revision of the Isopod Genus *Ligidium* Brandt [Crustacea].

Ivor G. S. Montagu, F.Z.S.

On some Mammals from Jugo-Slavia.

Ivor G. S. Montagu, F.Z.S., and Grace Pickford.

On the Guernsey *Crocidura*.

Major S. S. Flower, O.B.E., F.L.S., F.Z.S.

On Additions to the Snake Fauna of Egypt.

STANLEY HIRST, F.Z.S.

On some new or little-known Species of Acari.

CHAS. F. SONNTAG, M.D., F.Z.S.

On the Pelvic Muscles and Generative Organs of the Male Chimpanzee.

The following Papers have been received :—

CYRIL CROSSLAND, M.A., D.Sc., O.N., F.Z.S.

Polychæta of Tropical East Africa, the Red Sea, and Cape Verde Islands; and of the Maldive Archipelago.

MALCOLM A. SMITH, M.R.C.S., L.R.C.P., F.Z.S.

New Tree-Frogs from Indo-China and the Malay Peninsula.

ARTHUR LOVERIDGE, F.E.S., C.M.Z.S.

(1) Notes on East African Birds (chiefly Nesting-habits and Endo-parasites), collected 1920–1923.

(2) Notes on East African Snakes, collected 1918–1923.

(3) Notes on East African Tortoises, collected 1921–1923, with Description of a new Species of soft Land-tortoise.

(4) Notes on East African Lizards collected 1920–1923, with Descriptions of Two new Races of *Agama lionotus* Blgr.

(5) Notes on East African Insects collected 1915–1922.

R. R. MOLE, C.M.Z.S.

The Trinidad Snakes.

MARY L. HETT, F.Z.S.

On the Family Linguatulidæ.

Dr. FRANCIS, Baron NOPSCA.

Reversible and irreversible Evolution; a Study based on Reptiles.

J. R. GARROOD, M.D.

Two Skeletons of the Cetacean *Pseudorca crassidens* from Thorney Fen, Cambridgeshire.

E. W. SHANN, B.Sc., F.Z.S.

Investigations on the Comparative Myology of Fishes.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

Zoological Society of London,
Regent's Park, London, N.W. 8.
October 30*th*, 1923.

No. 245.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

November 6th, 1923.

Sir S. F. HARMER, K.B.E., F.R.S., Vice-President, in the Chair.

The SECRETARY exhibited, and made remarks upon, a photograph of a Ratel from Lake Magadi, Kenya.

Mr. D. SETH-SMITH, F.Z.S., exhibited, and made remarks upon, (1) a young Pigmy Hippopotamus purchased by the Society; and (2) a specimen of a Tree-Shrew found in a tin of Pineapple Chunks in syrup.

Mr. F. A. MITCHELL-HEDGES, F.Z.S., F.L.S., F.R.G.S., gave an account of his recent expedition through the jungle-region of Panama, and illustrated his remarks with a series of lantern-slides of scenery, natives, and large fish.

Mr. ARTHUR LOVERIDGE, F.E.S., C.M.Z.S., gave a *résumé* of his papers:—

(1) Notes on East African Birds (chiefly Nesting-habits and Endo-parasites), collected 1920–1923.

(2) Notes on East African Snakes, collected 1918–1923.

(3) Notes on East African Tortoises, collected 1921–1923, with Description of a new Species of soft Land-Tortoise.

(4) Notes on East African Lizards collected 1920–1923, with Descriptions of Two new Races of *Agama lionotus* Blgr.

(5) Notes on East African Insects collected 1915–1922.

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The Hon. Ivor G. S. Montagu, F.Z.S., communicated his paper "On some Mammals from Jugo-Slavia," and gave a *résumé* of his investigations in collaboration with Miss Grace Pickford, on "The Guernsey *Crocidura*."

In the absence of the Authors, the following papers were taken as read:—G. H. Goldfinch, "Notes on the African Crested Rat (*Lophiomys imhausi*)"; Harold G. Jackson, F.Z.S., "A Revision of the Isopod Genus *Ligidium* Brandt [Crustacea]"; Major S. S. Flower, O.B.E., F.L.S., F.Z.S., "On Additions to the Snake Fauna of Egypt"; Stanley Hirst, F.Z.S., "On some new or little-known Species of Acari"; Chas. F. Sonntag, M.D., F.Z.S., "On the Pelvic Muscles and Generative Organs of the Male Chimpanzee."

The next Meeting of the Society for Scientific Business will be held on Tuesday, November 20th, at **5.30** p.m., when the following Communications will be made:—

The Secretary.

Report on the Additions to the Society's Menagerie during the month of October, 1923.

The Secretary.

Exhibition of a Collection of Autographs recently presented to the Society by Mr. Hugh S. Gladstone, F.Z.S.

W. E. Le Gros Clark, F.R.C.S.Eng., F.Z.S.

Notes on the living Tarsier.

Dr. Francis, Baron Nopsca.

Reversible and irreversible Evolution; a Study based on Reptiles.

J. R. Garrood, M.D.

Two Skeletons of the Cetacean *Pseudorca crassidens* from Thorney Fen, Cambridgeshire.

Cyril Crossland, M.A., D.Sc., O.N., F.Z.S.

Polychæta of Tropical East Africa, the Red Sea, and Cape Verde Islands; and of the Maldive Archipelago.

Miss JOAN B. PROCTER, F.Z.S., F.L.S.

(1) On new and rare Reptiles from South America.
(2) On new and rare Reptiles and Batrachians from the Australian Region.

The following Papers have been received:—

MALCOLM A. SMITH, M.R.C.S., L.R.C.P., F.Z.S.

New Tree-Frogs from Indo-China and the Malay Peninsula.

R. R. MOLE, C.M.Z.S.

The Trinidad Snakes.

MARY L. HETT, F.Z.S.

On the Family Linguatulidæ.

E. W. SHANN, B.Sc., F.Z.S.

Investigations on the Comparative Morphology of Fishes.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W. 8.
November 13*th*, 1923.

No. 246.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

November 20th, 1923.

Dr. A. Smith Woodward, F.R.S., Vice-President, in the Chair.

The Secretary read a Report on the Additions to the Society's Menagerie during the month of October, 1923.

The Secretary exhibited an autograph letter of Sir Stamford Raffles, one of the principal founders of the Society, which had been presented by Mr. Cosmo Bevan, and a collection of autographs of 161 Naturalists, including the first President, Treasurer, and Secretary of the Society, presented by Mr. Hugh S. Gladstone, F.Z.S.

Sir Stamford Raffles' letter was dated August 13, 1821, and was written to Sir Everard Home. It announced the dispatch of the head of an elephant, preserved in alcohol, stated that the Babirussa, then believed to have a wider distribution, was restricted to Celebes and Moluccas, and discussed other matters of zoological interest.

In Mr. Gladstone's gift there were included autographs of H. W. Bates, the Naturalist of the 'Amazon,' de Blainville, Bleeker, Francis Day, Sir Joseph Hooker and his father (Sir William Hooker), D. W. Mitchell, Secretary of the Society 1847–1859, and Temminck.

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Mr. R. T. Gunther, M.A., F.Z.S., exhibited, and made remarks upon, (1) Vertebræ of a Mesozoic Crocodile showing the course of intercostal Arteries, and (2) the jaw-bone of *Ursus anglicus* Gunther, from the Cherwell Gravels.

Mr. W. E. Le Gros Clark, F.R.C.S.Eng., F.Z.S., communicated his paper "Notes on the Living Tarsier (*Tarsius spectrum*)."

Sir Sidney F. Harmer, K.B.E., F.R.S., Vice-President of the Society, communicated his paper on "Cervical Vertebræ of a gigantic Blue Whale from Panama."

In the absence of the Author, Dr. J. R Garrood, a *résumé* of his paper on "Two Skeletons of the Cetacean *Pseudorca crassidens* from Thorney Fen, Cambridge," was communicated by Sir Sidney F. Harmer.

Dr. Francis, Baron Nopsca, communicated his paper on "Reversible and irreversible Evolution; a Study based on Reptiles."

In the absence of the Authors, the following papers were taken as read:—Cyril Crossland, M.A., D.Sc., O.N., F.Z.S., "Polychæta of Tropical East Africa, the Red Sea, and Cape Verde Islands; and of the Maldive Archipelago." Miss Joan B. Procter, F.Z.S., "(1) On new and rare Reptiles from South America," "(2) On new and rare Reptiles and Batrachians from the Australian Region."

The next Meeting of the Society for Scientific Business will be held on Tuesday, February 5th, 1924, at 5.30 P.M.

A notice stating the Agenda for the Meeting will be circulated early in January.

The following Papers have been received:—

Malcolm A. Smith, M.R.C.S., L.R.C.P., F.Z.S.

New Tree-Frogs from Indo-China and the Malay Peninsula.

R. R. Mole, C.M.Z.S.

The Trinidad Snakes.

Mary L. Hett, B.Sc., F.Z.S.

(1) On the Family Linguatulidæ.

(2) Zoological Results of the Third Tanganyika Expedition conducted by Dr. W. A. Cunnington, F.Z.S., 1904–1905: Report on the Linguatulidæ.

E. W. Shann, B.Sc., F.Z.S.

Investigations on the Comparative Morphology of Fishes.

H. C. Chadwick, A.L.S.

On some Abnormal and Imperfectly Developed Specimens of the Sea-Urchin *Echinus esculentus*.

The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

Zoological Society of London,
Regent's Park, London, N.W. 8.
November 27th, 1923.

PAPERS (*cont.*).

LIST OF PLATES.

1923, Part IV. (pp. 661–1097).

NOTICE.

The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1923, p. . . . The Distribution is usually as follows:—

Part I. issued in March.
" II. " June.
" III. " September.
" IV. " December.

'Proceedings,' 1923, Part III. (pp. 483–659), was published on September 3rd, 1923.

The Abstracts of the 'Proceedings,' Nos. 244–246, are contained in this Part.

The dates of Publication of 'Proceedings 1830–1858 will be found in the 'Proceedings' for 1893, page 436.

The dates of Publication of 'Transactions 1833–1869 will be found in the 'Proceedings' for 1913, page 814.